IQstress®

OPERATION MANUAL

Version 8.6.1

MIDMARK®

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Part Number: 3-100-1110 Rev. C

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Physician's Responsibility

The measurements and test data provided by the Midmark IQstress® are for the exclusive use of licensed physicians or personnel under their direct supervision. The numerical and graphical results should be examined with respect to the patient's overall clinical condition, recording preparation quality, and general recorded data quality, which can affect the accuracy of reported data.

In addition, the interpretations provided by the Midmark IQecg® are for the exclusive use of licensed physicians or personnel under their direct supervision. Not all ECG abnormalities can be detected by a computerized or automated ECG analysis algorithm. The suggested interpretation, including numerical and graphical results, should be examined with respect to the patient's overall clinical condition.

Proper administration of the test is the physician's responsibility, as is making a diagnosis, obtaining expert opinions on the results, and implementing the correct treatment, if indicated.

The IQstress® test has been designed to create a patient baseline during the Learning Phase. Patients with abnormal or irregular heartbeats may have difficulty or may not be able to pass the Learning Phase of the stress test. These patients may not be suitable for the stress test.

ECG RECORDS MUST ALWAYS BE REVIEWED BY A QUALIFIED PHYSICIAN. DO NOT USE COMPUTER ECG ANALYSIS FOR THE PRESCRIBING OF EITHER TREATMENT OR NON-TREATMENT OF PATIENTS.

CAUTION: Federal Law restricts this device to sale by or on the order of a physician.

Related Documents

The following documents may be needed in order to operate Midmark diagnostic devices and software products with IQstress®:

- *IQmanager®* Software *Operation Manual* (Part number: 4-100-1200)
- *IQecg® Operation Manual* (Part number: 3-100-1115)
- Trackmaster® Medical Treadmill Owner's Manual that was included with the treadmill

All Midmark product Operation Manuals are located on the Midmark Operation Manuals CD (part number: 3-100-1000), included with every device, and can also be downloaded from midmark.com. For additional information contact Midmark Technical Service at 1-800-624-8950, option 2.

Precautions

Read the following precautions to ensure proper operation of this instrument:

1. Exercise Stress testing should be performed by properly trained and qualified personnel under the supervision of a physician. If the user is new to exercise Stress testing, see *Section XV, References* for links to the following guidelines concerning best practices, contraindications and additional resuscitation equipment (defibrillator, medications, etc.) that the facility may require:
   - *ACC/AHA 2002 Guideline Update for Exercise Testing*[1]
   - *AHA Exercise Standards For Testing And Training*[2]
   - *Guidelines for Clinical Exercise Testing Laboratories*[3]
2. The following contraindications are known to exist[4] for exercise Stress testing.
   - Acute myocardial infarction
   - High-risk unstable angina
   - Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic compromise

[1] Gibbons, R. J., Balady, G. J., Bricker, J. T., Chaitman, B. R., Fletcher, G. F., Froelicher, V. F., et al. (2000). *ACC/AHA 2002 Guideline Update For Exercise Testing: A Report of the American College Of Cardiology/American Heart Association Task Force On Practice Guidelines (Committee on Exercise Testing).* Retrieved from American College of Cardiology: www.acc.org/clinical/guidelines/exercise/dirIndex.htm

[2] Fletcher, G. F., Balady, G. J., Amsterdam, E. A., Chaitman, B. R., Eckel, R., Fleg, J., et al. (2001). *Exercise Standards for Testing and Training: A Statement for Healthcare Professionals From the American Heart Association.* Retrieved from Circulation: www.circ.ahajournals.org/cgi/content/full/104/14/1694

[3] Pina, I. L., Balady, G. J., Hanson, P., Labovitz, A. J., Madonna, D. W., & Meyers, J. (1995). Guidelines for Clinical Exercise Testing Laboratories: A Statement for Healthcare Professionals from the Committee on Exercise and Cardiac Rehabilitation. Retrieved from Circulation: http://circ.ahajournals.org/cgi/content/full/91/3/912

[4] Gibbons, R. J., Balady, G. J., Bricker, J. T., Chaitman, B. R., Fletcher, G. F., Froelicher, V. F., et al. (2000). Ibid.

- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute myocarditis or pericarditis
- Acute aortic dissection

3. Become familiar with the operations and procedures of the instrument prior to use.
4. Thoroughly read the Trackmaster® owner's manual included with the medical grade treadmill that will be used before operating it.
5. Installation and maintenance of the instrument:
   - Install and keep the instrument away from splashing water.
   - Do not install the instrument where humidity, ventilation, direct sunlight or air containing dust, salt, sulfur, etc. might affect it.
   - Protect the instrument from shock and vibration while transporting it.
   - Do not install the instrument in a chemical storage area or where gas is generated.
6. Preparation of the instrument prior to operation:
   - Verify proper instrument operation.
   - Check that all cable connections are safe and secured.
   - When in use with additional equipment, such as a computer, request the assistance of personnel familiar with the additional equipment, if needed.
7. Observe the patient and instrument closely during use. If any abnormality is observed, immediate proper action, such as stopping the operation of the instrument, should be taken for the safety of the patient.
8. Keep the instrument clean to ensure trouble-free operation for the next use.
9. In case of a malfunction, call a Midmark Technical Service at (800) 624-8950, option 2 and describe the problem precisely.
10. Inspect the instrument and accessories regularly.
11. Do not make any modifications to the instrument.
12. Environmental operating limits:

    Operation:

    - 59 to 95 °F (15 to 35 °C)
    - 30 to 75% humidity (non-condensing)
    - 760mm Hg +/- 20%.

    Storage/Shipping (batteries removed):

    - 4 to 120 °F (-15 to 50 °C)
    - 30 to 95% humidity (non-condensing)
    - 760mm Hg +/- 20%

DANGER: **There is a possible explosion hazard if used in the presence of flammable anesthetics.**

WARNING: The Trackmaster® Medical Treadmill's Owner's Manual contains important safety information. User must become familiar with the safety

features and operations of the stress system, including the treadmill, before patient use.

CAUTION: Replace the patient cable with Midmark patient cables equipped with built-in defibrillation protection. Contact Midmark Technical Service for cable replacement.

CAUTION: Windows® operating systems are multi-tasking operating systems that allow the user to simultaneously run multiple applications. During a Stress test, never allow another application to obscure the display of the software, as this may impair the ability to monitor the patient.

CAUTION: IQmanager® or electronic medical record applications will not interfere with the test software if the computer used meets the minimum requirements specified in *Section I, General Information*.
Do not proceed with a Stress test if the software appears sluggish or the scrolling waveform display appears slow. If this is experienced, stop the software, close all unrelated applications and try again. Contact Midmark Technical Service if difficulties persist.

CAUTION: Refer servicing to qualified service personnel only.

CAUTION: Electronic devices can be damaged by exposure to liquids. Do not use or store the IQecg® or any other components of the IQstress® system near any type of liquids.

I. General Information

A. Introduction

IQstress® with Trackmaster® TMX428

IQstress® with Trackmaster® TMX425

The info in this Operation Manual is provided for users of Stress system models Midmark IQstress® and IQmark® EZ Stress, which may include ECG models Midmark IQecg® or IQmark® Digital ECG. Future references of IQstress® in this document may include the following components:

Model	ECG Connection	Device Part Number	Kit Part Number
Midmark IQstress® with Midmark IQecg®	USB	1-100-1325	4-000-0332
			4-000-0334
			4-000-0336
	Serial	1-100-1305*	4-000-0332
			4-000-0334
IQmark® EZ Stress with IQmark® ECG	USB	1-100-1320*	4-000-0314*
	Serial	1-100-1300*	

*No longer in production.

> **NOTE:** This manual is intended for IQmanager® Diagnostic Workstation Software Version 8.6.1 users. If using the IQstress® through an EMR, please contact Midmark Technical Service for assistance with installation, setup and operation.

IQstress® is a software component of IQmanager®. IQstress® acquires twelve leads of ECG from the IQecg® module via a Universal Serial Bus (USB) or a Serial Port (COM),

analyzes the data, displays real time ECG and ST measurements on the computer display and controls the treadmill during a Stress test. IQstress® uses a Windows-compatible laser or ink jet printer for printing ECG rhythm strips during the Stress test and for printing final Stress test reports.

Upon completion of the Stress test, IQmanager® stores the Stress test report in the patient database. Users may then review, edit and print the report.

Other Midmark products can also be accessed from IQmanager®, such as, IQecg®, IQholter®, IQspiro®, IQvitals®, IQvitals® PC and Weight/Scale Interfaces. Contact the Midmark Sales Department for the latest information on available Midmark products or visit midmark.com.

B. Necessary Computer Skills

This manual is intended for a user capable of using Microsoft® Windows® based applications, has some understanding of PC operations, and is familiar with the basic operations of Windows®. It is designed as a comprehensive guide to educate the user on the operation and functions that are available with IQstress®.

C. System Configuration

The block diagram below illustrates the standard configuration of the IQstress® system. The primary components are a Windows-based PC, a printer, and the IQecg® acquisition module. Please refer to this diagram when setting up your IQstress® system.

NOTE: DO NOT USE in a thin-client environment.

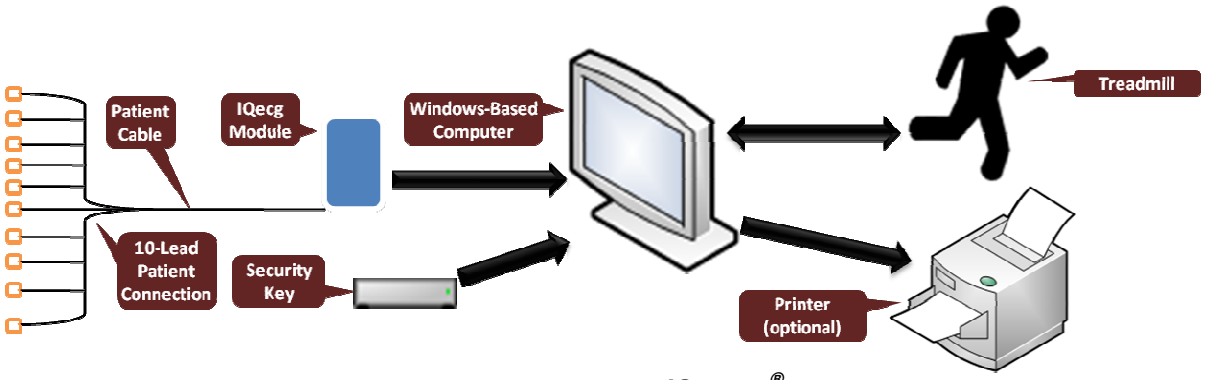


Figure 1-1 *Stress Testing System Configuration Using IQstress®*

D. System Specifications

The following are the software performance specifications for the IQstress®:

IQstress® Software Specifications	
Category	**Specification**
Intended Use	IQstress® is to be used under the supervision of a physician to monitor the patient's electrocardiograms from the human body surface during stress induced from exercise devices such as a treadmill or drug-induced (pharmacological) stress.
ECG Acquisition	Uses the Midmark IQecg® module
Treadmill Interface	Trackmaster® TMX425/428
ST Measurements	ST level and slope
ST Measurement Points	J+60 (default), J+80, J+user defined interval, J + HR variable interval. User adjustable isoelectric and J points.
Heart Rate	Eight beat sliding average. Range : 30-250 BPM, VE count per minute (VE/min).
ECG Display	3, 6 or 12 lead plus average beats.
Rhythm Strip Formats	6x2, 3, 6 or 12 leads plus average beats; 12 leads plus 1 rhythm lead; 10 seconds, 30 seconds or continuous rhythm strip matches leads display.
Software Filters	Muscle filter, AC filter, Drift filter
ECG Lead Configurations	Standard 12 lead, Cabrera 12 lead
Treadmill Exercise Protocols	Bruce, Modified Bruce, Balke-Ware, Ellestad, Naughton, Ramp, user programmable
Pharmacological Protocols	Dobutamine, user programmable
Reports	Cover page, summary table, average beats (summary or detailed), rhythm strips (summary or detailed), resting ECG report, trend report.
Configuration Profiles	IQstress® has five default configuration profiles, which store user preferences; profiles can be customized to tailor the system to individual preferences.

IQstress® uses the IQecg® Digital ECG module. The following are the physical and performance specifications for the IQecg® module.

Performance Specifications	
Category	**Specification**
Physical Characteristics	• Noninvasive device, 12-lead electrocardiogram • 3.5” (88mm) x 5.7” (145mm) x 1.2” (30mm) (W x L x H) • 10.2oz. (289.2 g) (USB-type ECG module without batteries)
Anatomical Sites	• Noninvasive device, 12-lead electrocardiogram
Safety Parameters	• Patient electrically isolated from main current supply • Patient leakage current not to exceed 10 uA • Ground leakage current not to exceed 50 uA
ECG Acquisition	• 12 lead simultaneous • Input impedance > 100M ohm • Frequency response 0.05-150 Hz –3 dB • Sensitivity: 5, 10, 20 mm/mV +/- 10% • Dynamic range: +/- 10 mV • ADC resolution: 13 bits at 2.44 uV/bit • Acceptable electrode offset: +/- 300 mV per AAMI EC-11 specifications • A/D 500 samples/sec
Patient Connection	• 10-lead patient cable with RFI filter, defibrillator protection and patient isolation
ECG Analysis & Measurement	• Midmark 12-Lead Resting Electrocardiogram Analysis Program.
Printer	• Windows-supported ink-jet or laser printer.
Paper	• Plain 8.5” x 11” (Letter size)

NOTE: For treadmill specifications refer to the Trackmaster® Owner’s Manual included with the treadmill.

II. System Setup and Installation

NOTE: Contact Midmark Technical Service before installing and setting up the IQstress®. Computers today are more complex with more software and hardware options than before, making each computer almost unique. Midmark wants to make sure that your IQstress® is installed and configured as quickly and easily as possible.

Midmark Technical Service can be reached at 1-800-624-8950, option 2.

A. Minimum Computer Requirements

This section describes the minimum computer resources and hardware components needed when using new Midmark devices and software. As is the nature of technology to change often, these requirements will be evaluated and modified periodically. We suggest always referring to the most recent *Minimum Computer Requirements* document at *www.midmark.com*, or contact Midmark Technical Service at 1-800-624-8950, option 2, for additional information.

NOTE: If updating existing computer systems currently being used with older Midmark devices and software, please contact Midmark Technical Service before doing so.

The following computer minimum requirements represent the IQstress® being operated without the Stress Output Module (SOM).

IQstress® Minimum Computer Requirements	
Item	**Requirement**
Operating Systems	Windows® 8, Professional and Enterprise, 32-bit and 64-bit Windows® 7, Professional and Enterprise, 32-bit and 64-bit
Hardware Requirements	Windows® compatible personal computer. Desktop model recommended.†
CPU	Intel® Core™2 Duo Processor E4300 (2M Cache, 1.80 GHz, 800 MHz FSB) (x86) or 64-bit (x64) processor or faster
Disk	2 GB of free disk space or greater
Memory	Minimum 2GB of system memory
Input/Output Ports	Two (2) USB ports and one (1) serial port or, one (1) USB port and two (2) serial ports: • One RS-232 COM/Serial Port for the treadmill. • One Universal Serial Bus (USB) port for the software security key. • One USB or serial port for the IQecg® module.

	An additional USB port is required if a Stress Output Module is used. USB to Serial port adapters are not recommended as a replacement for any of the components listed above. The above computer interfaces are required for new stress test acquisition. They are not required to review and/or edit a test. Additional USB ports as needed for keyboard, mouse, printer, etc.
Pointing Device	Windows® compatible mouse.
Keyboard	Windows® compatible keyboard.
Display	1024x768 or higher resolutions for the real time acquisition screen. 16-bit color. Wide-screen (1680x1050) is highly recommended.
Printer	Microsoft Windows® compatible inkjet or laser printer. **Note:** A high-speed laser printer is highly recommended for continuous rhythm strip printing.
Surge Protector	One (1) hospital grade power surge protector** for the computer system.
Stress Output Module (SOM)	IQstress® controls, version 8.6.1

NOTE: DO NOT USE in a thin-client environment.

The above is the minimum computer requirement specification for operating the IQstress® through IQmanager®. A faster CPU and/or more Memory may be needed if planning to operate the IQstress® through an EMR or install additional software.

†All-in-one desktops, laptops, and tablet computers are NOT recommended for performing live Stress test due to the resources demand of the application.

**A 110VAC Uninterruptible Power Supply (UPS) in place of the hospital grade power surge protector is highly recommended to protect the computer system from power spikes, surges and brown-outs. In the event that there is an interruption to the power, an UPS can provide a few minutes of reserve so you can exit and save the test immediately.

It is recommended that the ECG module and treadmill be connected directly to the computer instead of a USB hub, if one is used.

USB ports/contacts can become worn with repeated use. The IQstress test may not function with this specific USB port.

B. Computer Setup

NOTE: If IQmanager® is already installed on the computer and are now either upgrading or adding a new Midmark product, please ***skip*** this section and refer to the *IQmanager® Operation Manual* for installation information.

Before installing IQmanager® on a computer, it is important to understand and carry out the following tasks:

Windows Taskbar

IQmanager® is designed to run as a full-screen program. For best results, the Windows Taskbar should not be displayed in order to provide maximum display area. Place the mouse pointer on the blank portion of the Taskbar on the bottom of the screen, then right-click and select **Properties**. Check the *Auto-hide the taskbar* box to hide the taskbar when it is not in use; to display the taskbar when it is hidden, move the cursor over the area where the taskbar is normally set, and it will reappear.

Screen Saver

If a screen saver or any energy saving feature is enabled on the computer, make sure that it does not activate and interfere with data acquisition during patient care. Refer to your computer or software manual for these settings.

C. Software Installation

NOTE: The following software installation information refers to IQmanager® only. If using an IQstress® through an EMR, please contact Midmark Technical Service for assistance with installation and setup.

The medical diagnostic application IQstress® uses IQmanager® to manage patient records. When installing or upgrading the IQstress®, IQmanager® is automatically installed or upgraded accordingly (Refer to the *IQmanager® Operation Manual* for further information).

NOTE: Close all Windows programs before installing this software. Do not interrupt the installation program while it is running. The installation should take less than five minutes.

NOTE: If using the Stress Output Module (SOM) be sure it is not connected to the computer during this software installation. If the SOM was connected to the computer during the installation; 1) wait for the installation to complete, then 2) disconnect the SOM and reconnect it to the computer.

1. Insert the IQmanager® Installation CD into the CD-ROM or DVD-ROM drive. The installation starts automatically. If the installation does not start automatically, double-click **My Computer** on the desktop and double-click the CD-ROM icon to start.
2. Follow the instructions on the screen. For detailed installation, setup and detailed operation instructions, please refer to the *IQmanager® Operation Manual*.

Once the software has been installed the user will be able to review and edit Stress test reports. In order to perform new Stress tests, connect the hardware components to the computer and configure the software to operate with the appropriate hardware configuration as described in the following sections.

D. Hardware Setup

This section describes how to connect hardware components only to the computer to be used for performing Stress tests; computers used only for reviewing, editing and printing Stress reports do not require any special hardware.

See *Figure 1-1, Stress Testing System Configuration Using the IQstress® Software*.

1. Connect the ECG module to a USB port on the computer

2. Connect the security key to the USB port on the rear panel of the computer.

3. Connect the treadmill (Trackmaster® Model TMX425 or TMX 428) to a serial port on the computer.

NOTE: To print rhythm strips or the final report from this computer, connect a Windows-compatible printer. Refer to the printer manual for information.

4. Connect the Stress Output Module (SOM), if included, to a USB port on the computer.

Hardware Configuration Settings

IQmanager® can be customized by using the configuration settings. Access the **Configuration Settings** by one of the following ways:

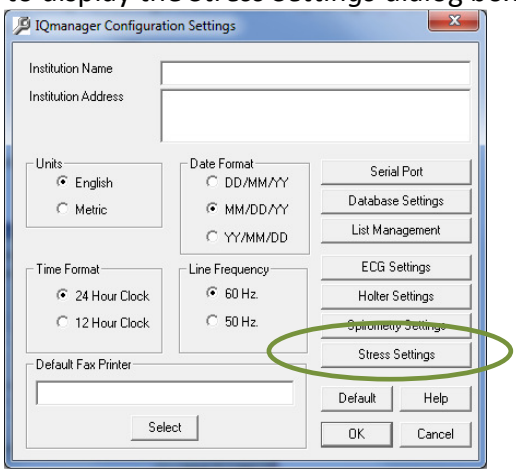
Double-click the shortcut installed on the desktop

, or Click on the **SETTINGS** button in the upper right side of the IQmanager® opening screen

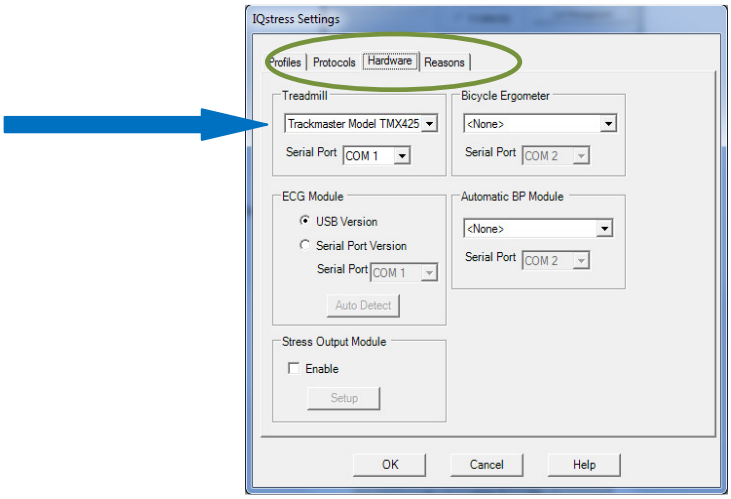
.

This will display the *IQmanager Configuration Settings* dialog box.

1. Click **Stress Settings** to display the *Stress Settings* dialog box.



2. Click the *Hardware* tab.



3. Select ***Trackmaster Model TMX425*** from the *Treadmill* list.

NOTE: The *Trackmaster Model TMX425* selection supports both the TMX425 and TMX428 medical treadmill models.

4. Select the version ECG module being set up by selecting either *USB Version* or *Serial Port Version*.
   - If using the serial port version of the ECG module and do not know which serial port it is connected to; click **Auto Detect**. The software will search the serial ports on the computer and determine the correct serial port setting.

NOTE: For best system performance, it is recommended that to use the USB version of the ECG module.

E. Configuration Settings

The software provides an extensive number of configuration settings that allow the user to customize the software to operate in accordance with specific preferences.

- Customizable user profiles contain a full set of configuration settings specific to each user's requirements and determine system operation for the Pre-Exercise, Exercise and Recovery phases, as well as settings for customization of ST measurements, HR and METS, report printing, report settings and miscellaneous items.

- Create new exercise profiles for treadmill, Ramp treadmill and pharmacological tests.

- Exercise protocols specify the manner in which a Stress test proceeds during the Exercise phase of the test (i.e., Bruce protocol), with the work level of each stage determined by the treadmill speed and grade. The software provides a set of standard protocols and provides tools to create customized protocols.

    - Exercise protocols are managed independently of user profiles. To use a new exercise protocol, first create the new protocol, then select that protocol for use in the Exercise phase of the user profile.

When running Stress tests, connect the ECG module and exercise device (i.e., treadmill) to the computer running the test. The *Hardware Settings* allow the user to configure the computer to communicate with these components. The *Hardware Settings* are not required for computers to be used only for review and edit functions.

To configure the software, display the *IQmanager Settings* dialog box:

- From the *IQmanager Configuration* utility: click **Stress Settings**
- From *Summary Review* screen of a Stress report: click **Settings**
- From the *Pre-Test Settings* dialog box: click **Settings**

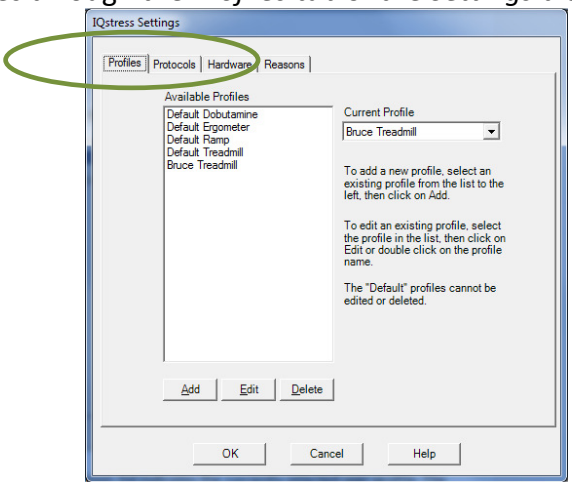
The *Settings* dialog box contains four tabs:

- ***Profiles*:** Manage user profiles.
- ***Protocols*:** Manage exercise protocols.
- ***Hardware*:** Manage devices and computer configuration.
- ***Reasons*:** Manage the *Reasons for Termination* list.

NOTE: Selection for a bicycle ergometer is provided, however, this version of the software does not support an interface to bicycle ergometers.

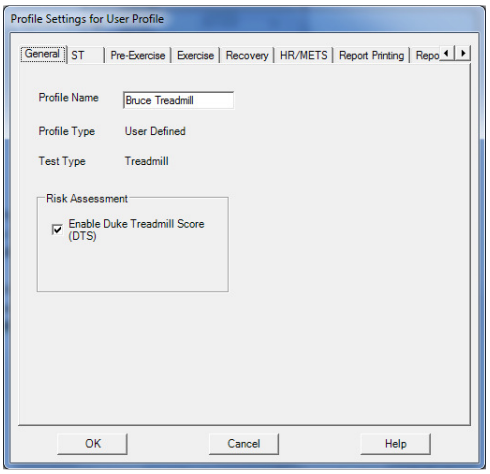
F. Managing User Profiles Settings

Manage user profiles through the *Profiles* tab of the *Settings* dialog box.

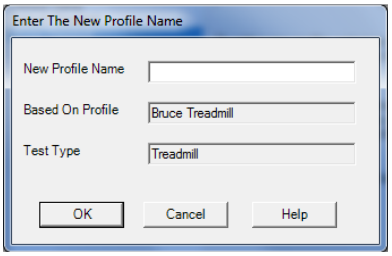


The *Current Profile* drop-down list indicates the currently selected user profile. The software uses these settings to determine system operation during a new Stress test, review and edit operations and for printing reports.

To edit an existing user profile, click on the profile in the list then click **Edit** or double-click on the name.

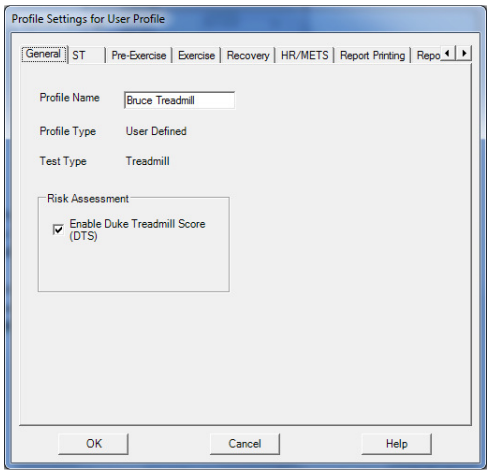


To add a new profile, select a profile in the list to use as a template then click **Add**. The *Profile Settings* dialog box appears.



The *Test Type* determines the type of test for the new profile (i.e., selecting the *Default Treadmill* profile applies to a treadmill type of test). The available test types are treadmill, Ramp and pharmacological.

The *Default* profiles cannot be changed, although the settings can be viewed by selecting the profile and clicking **Edit**. Changes will not be saved for these profiles.



General Settings

On the *General* tab, type in the name of the profile in the *Profile Name* edit box.

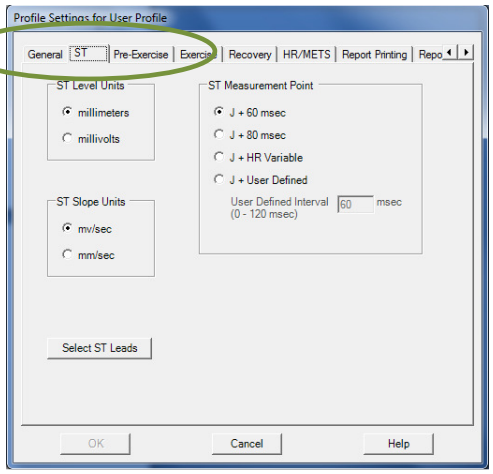
Check the *Enable Duke Treadmill Score (DTS)* box if the Duke Treadmill Score is to be included in the final report. See *Appendix B, Physician's Guide to the Duke Treadmill Score* for more information.

ST Settings

The *ST Settings* tab specifies the units to use for ST level and slope and the measurement point to use when displaying ST level and slope.

The software calculates the ST level and slope for each average beat at all four of the following measurement points.

- J + 60 msec. (default)
- J + 80 msec.
- J + HR Variable
- J + User Defined Interval



The setting in the *ST Measurement Point* determines which measurement points are shown in the screens and reports.

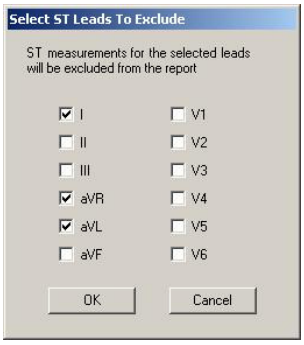
When using the *J + HR Variable ST* measurement point, the software varies the ST measurement point relative to the J point according to the current heart rate by using the following equation.

$$t = 2 * \sqrt{RR}$$

- *t* is the interval in milliseconds between J point and the ST measurement point.
- *RR* is the average RR wave interval calculated from the average heart rate.

The above equation sets the ST measurement point (J+t) at about 10 ms for a heart rate of 250 BPM and at about 63 ms for a heart rate of 60 BPM.

Clicking **Select ST Leads** displays the *Select ST Leads to Exclude* dialog box to select which ECG leads to ignore in the ST measurement calculations.

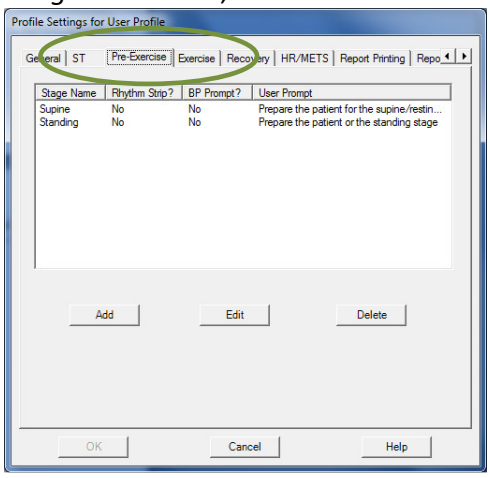


The ECG leads selected in this dialog box define the default lead selections and those that will not be included in the reported ST measurements each time a Cover Page Report or a Summary Table Report is created.

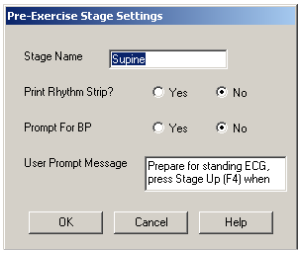
These settings can be overridden for an individual report in the *Average Beat Review* screen after the report is saved.

Pre-Exercise Settings

Access the *Pre-Exercise Settings* tab to add, edit or delete Pre-Exercise stages.



Click **Add** or **Edit**, to display the *Pre-Exercise Stage Settings* dialog box.



- Change the name of the stage by typing it in the *Stage Name* edit box.

- To configure the software to automatically print a rhythm strip when leaving the stage, select ***Yes*** next to the *Print Rhythm Strip* option.

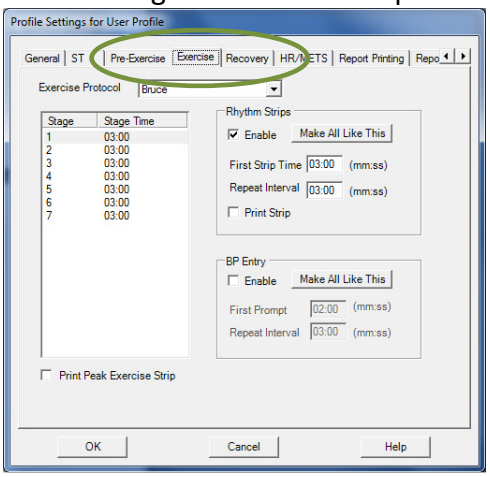
NOTE: The software automatically saves a rhythm strip at the end of each Pre-Exercise stage even if it is not printed.

- Select *Yes* next to the *Prompt For BP* option to automatically display a BP prompt dialog box at the beginning of the Pre-Exercise phase.

- The *User Prompt Message* text appears in the message prompt area of the *Exercise Test* screen at the beginning of the Pre-Exercise stage.

Exercise Settings

The *Exercise* tab configures the settings for the Exercise phase of the Stress test.



The ***Exercise Protocol*** drop-down list configures how the software will control the exercise device. Select any protocol from the drop-down list.

> **NOTE:** A user cannot edit an exercise protocol from the *Exercise Settings* tab. To edit an existing protocol or to create a new one, go to the *Protocol* tab of the *IQstress Settings* dialog box.

The list on the left side of the dialog box shows the stages for the selected protocol. Configure individual settings for rhythm strips and BP entry for each stage of the protocol, or configure the same settings for all stages.

To enable automatic print of the peak exercise ECG strip immediately after the exercise phase, check the ***Print Peak Exercise Strip*** box.

The ***Rhythm Strips*** group of controls is for setting rhythm strip storage and printing parameters for an Exercise stage.

- Check the ***Enable*** box to enable storage of rhythm strips.

- Enter the when during the stage to begin storing rhythm strips in the ***First Strip Time*** edit box.

- To store or print more than one rhythm strip during the stage, enter an interval in the ***Repeat Interval*** edit box.
    - To save or print only one strip in the stage, enter a value of 00:00 in the ***Repeat Interval*** edit box.

- To print a rhythm strip at the specified time, check the Print box.
    - Leave this box un-checked to save a rhythm strip without printing it.

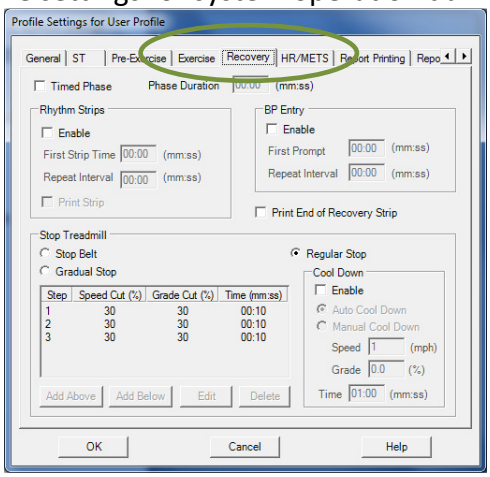
The BP Entry group of controls determines if and when to prompt for blood pressure readings.

- Check the Enable box to display a prompt dialog for BP entry.
- Enter when during the stage the first prompt is to appear in the First Prompt edit box.
- To prompt for BP periodically, enter the prompt interval in the Repeat Interval.
- Enter a value of 00:00 to prompt only once in the stage.

Click **Make All Like This** to apply the respective settings to all stages in the Exercise protocol.

Recovery Settings

The ***Recovery*** tab shows the settings for system operation during the Recovery phase.



- Check the ***Timed Phase*** box to make the Recovery phase a timed phase and enter the duration in the *Phase Duration* edit box.

- The ***Rhythm Strips*** group of controls determines if and when the software saves and/or prints rhythm strips during the recovery phase. These controls operate the same as the *Rhythm Strip* settings for Exercise phase.

- The ***BP Entry*** group of controls determines if and when the software prompts the user for BP entries. These controls operate the same as the *BP Entry* settings for Exercise phase.

- The ***Stop Treadmill*** option adjusts the speed at which the treadmill will slow down.
  Stop Belt immediately stops the treadmill belt without changing its grade.
  Gradual Stop provides a user defined gradual decrease in treadmill speed and grade.
  Regular Stop stops the belt at a preset rate while the treadmill declines to 0% grade.

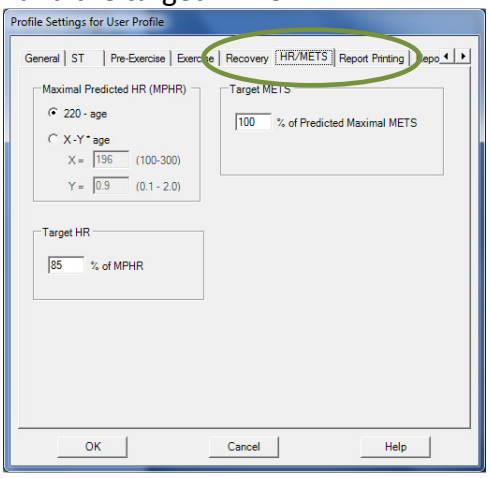
- ***Stop Belt*** option is useful for stress echo procedure which the patient needs to move quickly to an exam table as soon as the exercise phase is completed.

- Check the ***Enable*** check box in the ***Cool Down*** control group to add a cool-down stage to the Recovery phase. ***Cool Down*** option is available only when ***Regular Stop*** is selected.
  - Enter the duration of the cool-down stage in the ***Time*** edit box and the desired treadmill speed and grade.

- Check the ***Print End of Recovery Strip*** box to automatically print the last ECG strip of the Recovery phase.

HR/METS Settings

The *HR/METS* tab allows the user to specify the equations to use for the predicted maximal HR, the target HR and the target METS.



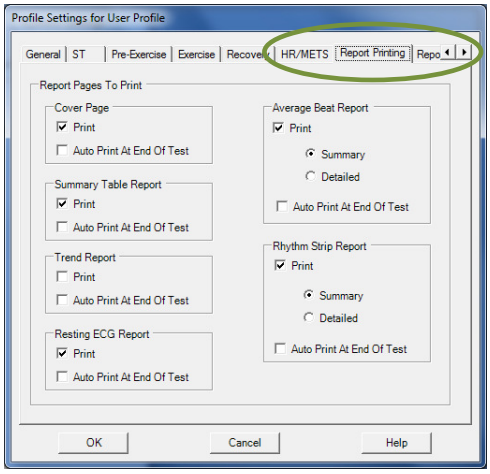
The ***Predicted Maximal HR*** group of controls determines how the software calculates the predicted maximal HR for patients.

The ***Target HR*** setting determines how the software calculates target HR from the predicted maximal HR for patients. A value of 100% indicates that the target HR is equal to the predicted maximal HR (maximal Stress test). A value less than 100% specifies a sub-maximal Stress test. For example a setting of 80% sets the target HR to 160 BPM if the predicted maximal HR is 200 BPM.

The ***Target METS*** setting specifies how the software calculates the target METS from the predicted maximal METS for patients.

Report Printing Settings

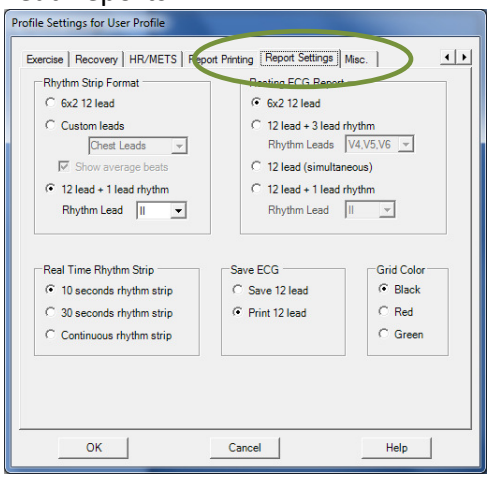
The settings on the *Report Printing* tab determine which Stress report pages are printed. To print report pages automatically at end of test, check the ***Auto Print At End Of Test*** checkbox.



The ***Rhythm Strip Report*** section describes the Summary and Detailed Rhythm Strip Report formats. The ***Average Beat Report*** section describes the Summary and Detailed Average Beat Report formats.

Report Page Settings

This tab contains settings for the waveform reports, which affect the Rhythm Strip, Resting ECG and Average Beat Reports.



The ***Rhythm Strip Format*** section determines the print format for the following:

- Timed or pre-programmed rhythm strips through ***User Profile Settings***
- Printed ECG by clicking button in the ***Freeze ECG*** window

The ***Resting ECG Report*** setting determines the ECG format for Resting ECG performed during pre-exercise phase.

The ***Real Time Rhythm Strip*** section dictates the printout when the **Print Scrn** button is used during live test. The ECG leads used for rhythm strip printing are the same as the leads displayed on the real time screen. No average beats will be printed.

- 10 seconds rhythm strip (default)
- 30 seconds rhythm strip
- Continuous rhythm strip

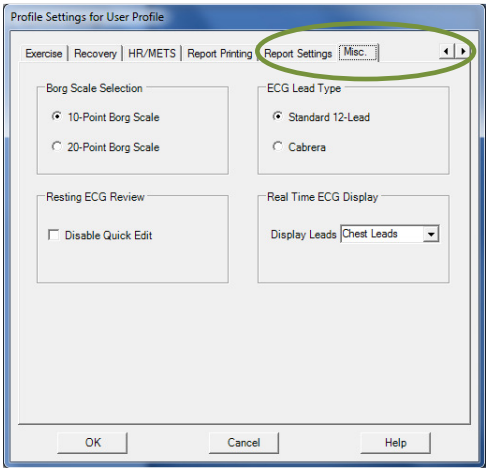
The page number for the rhythm strips will be printed as Page1, Page 2, ...

> **NOTE:** For best performance, a high-speed laser printer is recommended. A slow printer will take more than 10 seconds to print a 10-second rhythm strip, which result in the rhythm strips being printed out of real-time. However, all 10-second rhythm strips will be printed eventually from the printer queue. The 10-second rhythm strips will also be saved in the Stress test report for reviewing, editing and printing.

The ***Grid Color*** setting determines the printed grid color for all three of the waveform reports.

Miscellaneous Settings

The *Miscellaneous* tab contains various settings such as Borg scale and ECG lead system.



Borg Scale Selection

The ***Borg Scale*** radio buttons choose between the 10-point and the 20-point Borg scale.

Ten-Point Borg Scale	
Points	**Perceived Effort**
0	Nothing at all
0.5	Extremely light (just noticeable)
1	Very light
2	Light
3	Moderate
4	Somewhat heavy
5	Heavy (strong)
6	
7	Very heavy
8	
9	
10	Extremely heavy (almost maximal)
--	Maximal

20-Point Borg Scale	
Points	**Perceived Effort**
6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

ECG Lead Type

The ***Standard 12-Lead*** setting configures the software to use the standard lead ordering for showing ECG data: I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6.
The ***Cabrera*** setting configures the software to use the Cabrera representation of the ECG leads: aVR is inverted (–aVR); the lead order is aVL, I, -aVR, II, aVF, III, V1, V2, V3, V4, V5, V6.

Disable Quick Edit

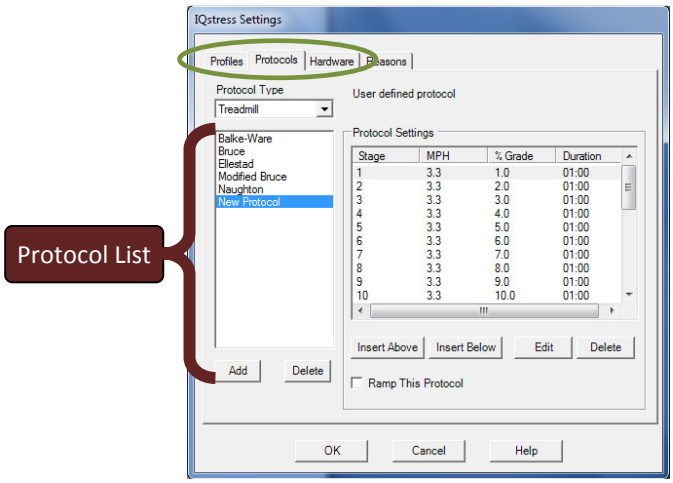
This setting determines how the *Add New Statement* dialog box is used in the *Resting ECG* screen. When *Disable Quick Edit* is checked, the software defaults to free text entry for adding diagnostic statements, instead of the drop-down list on the *Add a Statement* dialog box. The default is for the *Disable Quick Edit* box to be unchecked.

Exercise Test Screen Display Leads

The *Display Leads* drop-down list of the *Real Time ECG Display* control group determines the default *View Control Leads* setting displayed on the *Exercise Test* screen once the test enters the Pre-Exercise phase. Note that, during the Hookup phase, this screen initially shows all 12 leads for easy verification of ECG quality.

G. Managing Exercise Protocols

The *Protocols* tab of the *Settings* dialog box allows the user to manage exercise protocols.



The ***Protocol Type*** drop-down list displays the type of protocol selected from the list. The drop-down list contains the following selections:

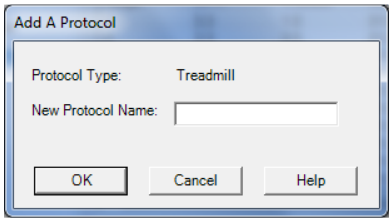
- Treadmill
- Ramp Treadmill
- Pharmacological

When the *Protocol Type* changes, the list changes to show all stored protocols for that test type.

The ***Protocol Settings*** group controls apply to the selected protocol.

The ***Type Display*** indicates the type of the protocol. Default protocols may not be edited or deleted; user-defined protocols may be edited or deleted.

To add a new protocol, select a protocol from the list to use as a template and click **Add**. The *Add a Protocol* dialog box appears.



NOTE: Adding a new protocol or selecting a protocol from the list does not mean that the new protocol will be used when performing a Stress test. To select a protocol that has been created, specify that protocol in the *Exercise Phase Settings* tab of the selected user profile.

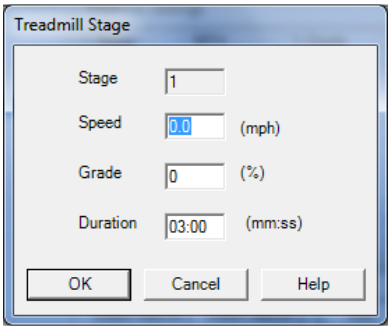
To edit a protocol, select it from the list then use the controls in the *Protocol Settings* group to change the stages of the selected protocol.

- For treadmill and pharmacological protocols, clicking **Insert Above**, **Insert Below**, **Edit** or **Delete** allows the user to edit the stages of the selected protocol.

- ***Ramp This Protocol*** applies only to treadmill protocols and causes the software to gradually increase the workload from one stage to the next instead of stepping the workload.

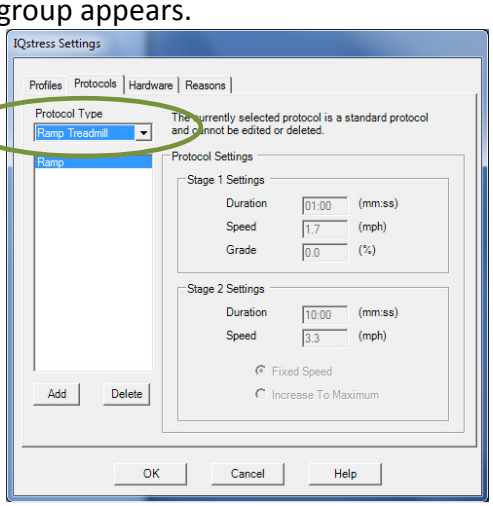
Programming Treadmill Protocols

When editing the stages of a treadmill type protocol, the ***Treadmill Stage*** dialog box allows you to enter the speed, grade and stage duration (minutes:seconds).



Programming Ramp Protocols

When selecting a ***Ramp Treadmill*** protocol from the *Protocol Type* drop-down list, the *Protocol Settings* control group appears.



Ramp protocols increase the work load on the patient by gradually increasing the treadmill grade and/or speed to a maximum value that is customized for each patient.

Ramp protocols consist of an optional warm-up stage and a ramping stage. In the warm-up stage, the software runs the treadmill at a fixed speed and grade to allow the patient to warm up before beginning to exercise.

The ***Stage 1 Setting*** group contains the settings for the warm-up stage and the *Stage 2 Settings* group contains the settings for the ramping stage. If there will be no warm-up stage, set the *Duration* edit box to 00:00 in the *Stage 1 Settings* group.

The ***Duration*** setting in the ***Stage 2 Settings*** group sets the desired test time. This value is typically between 8 and 12 minutes.

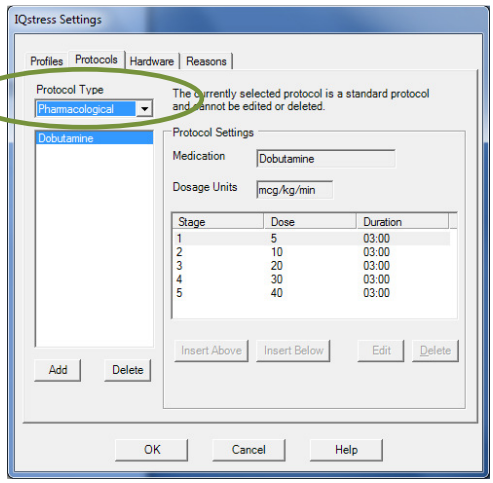
There are two different types of ramping stages depending upon the *Stage 2 Settings*:

- If ***Fixed Speed*** is selected, the software sets the treadmill to the value shown in the ***Speed*** edit box and gradually increases the treadmill grade.

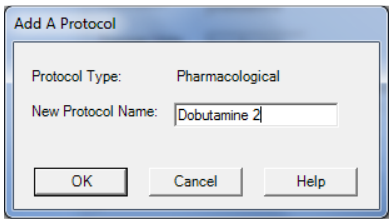
- If ***Increase To Maximum*** is selected, the software increases the speed to the value shown in the *Speed* edit box and gradually increases the treadmill grade.

Programming Pharmacological Protocols

The *Protocols* tab allows the user to program pharmacological protocols.

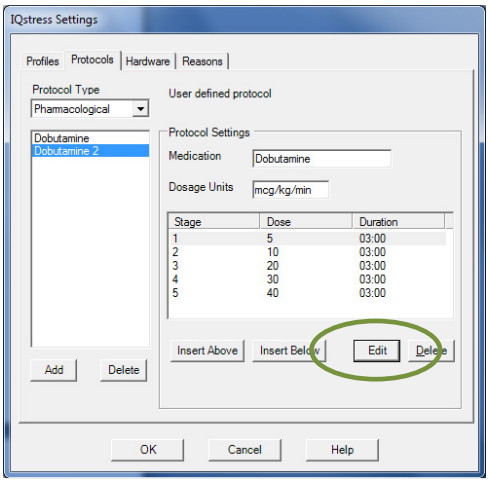


Enter the name of the medication in the ***Medication*** edit box and the ***Dosage Units*** in that edit box (e.g., mcg/kg/min for micro grams per kilogram per minute).

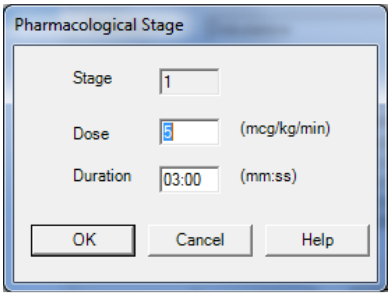


To edit a medication protocol to an existing stage: The ***Pharmacological Stage*** dialog box allows the user to enter the dose for that stage and the stage duration.

- Highlight the medication prototol type to be edited, click the **Edit** button

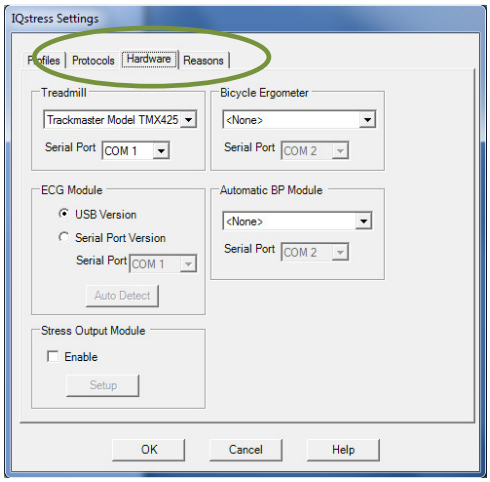


- Make the changes needed. Click **OK** when done.



H. Hardware Settings

The *Hardware* tab of the *IQstress Settings* dialog has controls to select the type of treadmill to be used, specify the serial port that the treadmill is connected to and to select the type of ECG module being used.



NOTE: The Midmark IQstress® systems support Trackmaster® Medical Treadmill models TMX 425 and TMX 428. The *Trackmaster Model TMX425* selection supports both these models.

NOTE: There are no bicycle ergometer selections available because this version of the software does not support an interface to bicycle ergometers.

If using the USB version of the ECG module, select the *USB Version* radio button, which prevents the software from running an auto detection sequence that searches all of the serial ports if the ECG module is not yet attached to the computer.

NOTE: For the best system performance, the USB version of the ECG module is recommended.

Controls - Stress Output Module

The ***Stress Output Module*** (SOM) group of controls allows the user to configure the system for operation with the SOM, a separate box that interfaces to the computer running the software and provides digital and analog outputs for interfacing to auxiliary equipment such as echocardiographs (for Stress echo procedures) and automatic blood pressure measurement systems.

- If a SOM is connected to the computer on which Stress tests will be performed, then the Enable box should be checked; otherwise, this box should be cleared.

- Click **Setup** to configure the SOM. See *Section* *VIII-A, Stress Output Module Configuration* for instructions.

NOTE: To maintain best system performance, the SOM only works with the USB version of the ECG module.

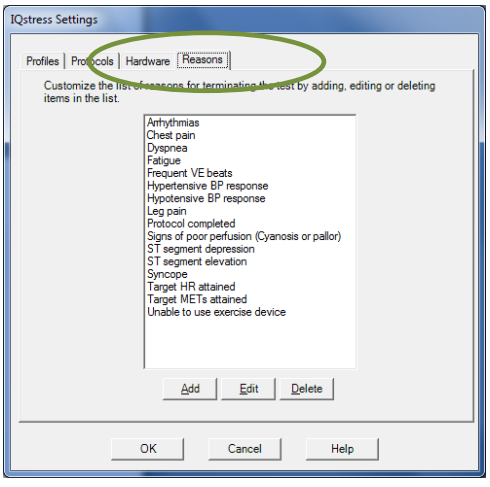
Controls – Automatic BP Module

The ***Automatic BP Module*** group of controls configures the software for use with an automatic BP measurement device such as the SunTech® Tango® or Tango®+ device.

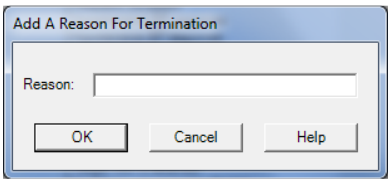
- Select the device type from the drop-down list; currently, the selections are *None* (default) and SunTech® Tango®. If using a SunTech® Tango® or Tango®+ device, select *SunTech Tango* and select the serial port in the drop-down list; otherwise, select *None*. See *Section IX-B, Using the SunTech® Tango® Automatic BP Unit with IQstress*® for instructions on how to configure and use the software with the SunTech® Tango® device.

Reasons for Termination List Customization

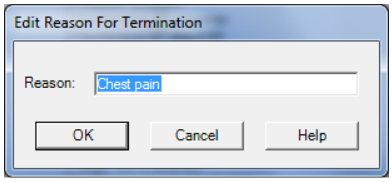
At the end of a Stress test, select the reason for terminating the test from a list of statements. The *Reasons* tab of the *IQstress Settings* dialog box allows the user to customize this list.



To add an item to the list, click **Add**, which displays the *Add a Reason for Termination* dialog box.



To edit a reason, select an item from the list and click **Edit** to display the *Edit Reason* dialog box.

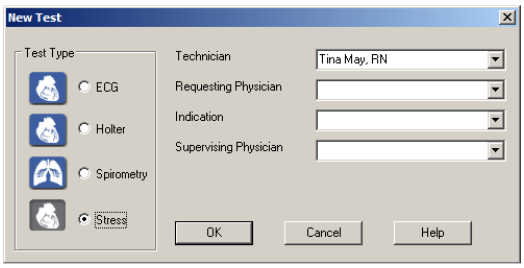


To delete an item, select it from the list and click **Delete**.

III. Stress Test Operation

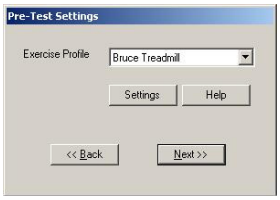
A. Starting a New Stress Test

1. Click **New Test**; the *New Test* dialog box appears:



2. Select a Stress test by clicking **Stress**. Enter the name of the technician performing the test, the requesting physician, the indication or reason for performing the test and the name of the supervising physician. Select these items from pre-programmed lists. Refer to the *IQmanager® Operation Manual* for information on how to customize these lists.

3. Click on **OK** to proceed. The *Pre-Test Settings* dialog box appears:



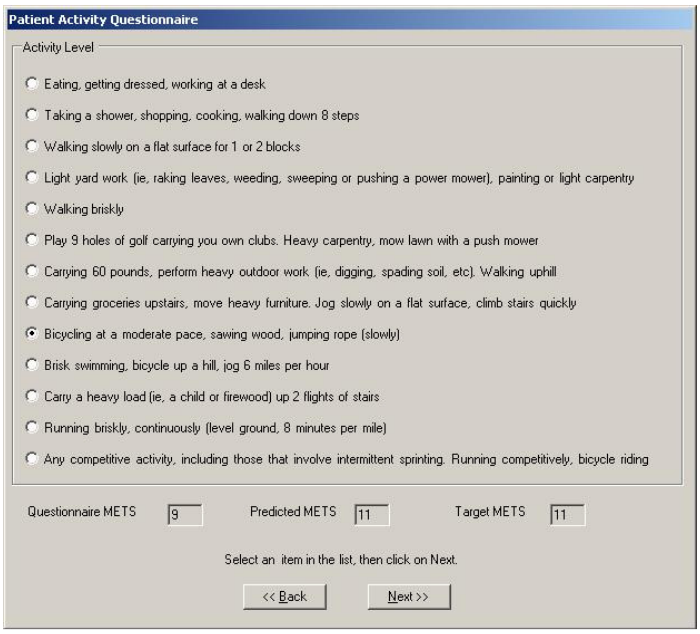
4. Select an *Exercise Profile* from the drop-down list Profiles store pre-programmed settings that determine how the Stress test procedure is conducted along with a variety of user preferences.

5. Click **Settings** to change system configurations and to program or edit user profiles. See *Section II-E, Configuration Settings* for more information.

6. Click **Next** to proceed to the Hookup phase of the test and begin patient preparation. The *Hookup Screen* appears.
    - If performing a Ramp protocol, the software will display the *Patient Activity Questionnaire* dialog box. Enter the patient's level of physical activity and click **Next** to display the *Hookup Screen* and begin patient preparation for the test.

Ramp Protocol Patient Activity Questionnaire

For the Ramp exercise protocol, the *Patient Activity Questionnaire* dialog box appears:


Patient Activity Questionnaire
Activity Level
Eating, getting dressed, working at a desk
Taking a shower, shopping, cooking, walking down 8 steps
Walking slowly on a flat surface for 1 or 2 blocks
Light yard work (ie, raking leaves, weeding, sweeping or pushing a power mower), painting or light carpentry
Walking briskly
Play 9 holes of golf carrying you own clubs. Heavy carpentry, mow lawn with a push mower
Carrying 60 pounds, perform heavy outdoor work (ie, digging, spading soil, etc). Walking uphill
Carrying groceries upstairs, move heavy furniture. Jog slowly on a flat surface, climb stairs quickly
Bicycling at a moderate pace, sawing wood, jumping rope (slowly)
Brisk swimming, bicycle up a hill, jog 6 miles per hour
Carry a heavy load (ie, a child or firewood) up 2 flights of stairs
Running briskly, continuously (level ground, 8 minutes per mile)
Any competitive activity, including those that involve intermittent sprinting. Running competitively, bicycle riding
Questionnaire METS
9
Predicted METS
11
Target METS
11
Select an item in the list, then click on Next.
<< Back
Next >>

Query the patient about their daily level of physical activity and select the appropriate item in the dialog box. The software calculates the Target METS according to the selection in the dialog box then uses the Target METS to determine the work increment for the treadmill.

Click **Next** to proceed to the *Hookup Screen* and begin patient preparation. Click **Back** to return to the *Pre-Test Settings* dialog box.

> **NOTE:** The *Patient Activity Questionnaire* dialog box appears only when using a Ramp protocol.

Hookup Screen

In the Hookup phase, prepare the patient for the test by connecting the electrodes and verifying the ECG tracing quality. See *Section III-B, Patient Preparation* for more instructions.

During the Hookup phase, the *Average Beat* displays will remain blank.

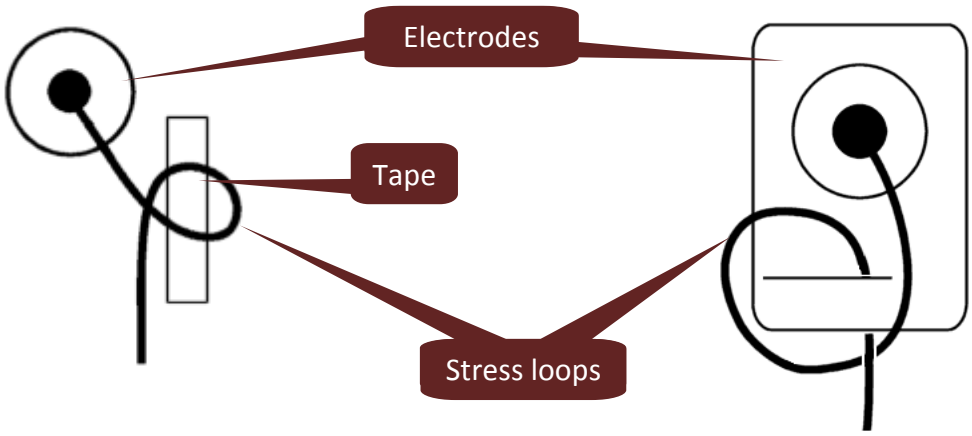
When satisfied with the ECG tracing quality, click **Stage Up (F4)** to allow the software to learn the ECG, which requires approximately 30 seconds. The phase indication will show *Learning*.

B. Patient Preparation

Skin Preparation

Careful preparation of the patient's electrode sites is essential for obtaining an interference-free ECG and accurate result, especially in exercise stress testing. The skin is naturally a poor conductor of electricity and frequently creates artifact that distorts the ECG signal due to dry or dead epidermal cells, oils, sweat and dirt.
Well managed skin preparation, will reduce the resistive barrier that causes muscle noise and baseline wander, ensuring high-quality signal and test data.

1. Shave the electrode sites to remove body hair.
2. Gently scrub the skin with an abrasive pad, lint-free gauze pad or fine sandpaper enclosed in the preparation kit. This loosens and removes dead skin.
3. Wipe the scrubbed area with a clean alcohol pad and ensure the entire electrode site is free of oil. Repeat for all sites. Allow these areas to air dry naturally before attaching electrodes.
4. Apply the electrodes to the sites indicated below.
5. Form a stress loop (see examples below with each electrode lead then tape the loop to the skin. This reduces artifacts caused when leads are pulled or tugged by patient movements.

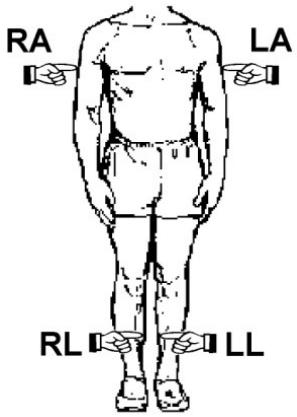


Examples of stress loops

If acquiring a resting ECG tracing during the Pre-Exercise phase, prepare both the resting limb electrode sites and the exercise limb electrode sites. Initially place the limb electrodes on the resting ECG sites. You can then move them to the exercise sites after acquiring the resting ECG strip.

NOTE: The live ECG acquisition screen will show the signal tracings after all limb leads have been connected. When the right-leg (RL) lead becomes detached, the system behaves as if all electrodes were disconnected.

Limb Lead Placement For Resting ECG



***RA (White/White)*:** Right Arm electrode is placed on a distal portion of the right lateral side of the upper arm below the shoulder.

***LA (Black/White)*:** Left Arm electrode is placed on a distal portion of the left lateral side of the upper arm below the shoulder.

***RL (Green/White)*:** Right Leg electrode is placed on the inside calf, midway between knee and ankle.

***LL (Red/White)*:** Left Leg electrode is placed on the inside calf, midway between knee and ankle.

Limb Lead Placement for Exercise Test

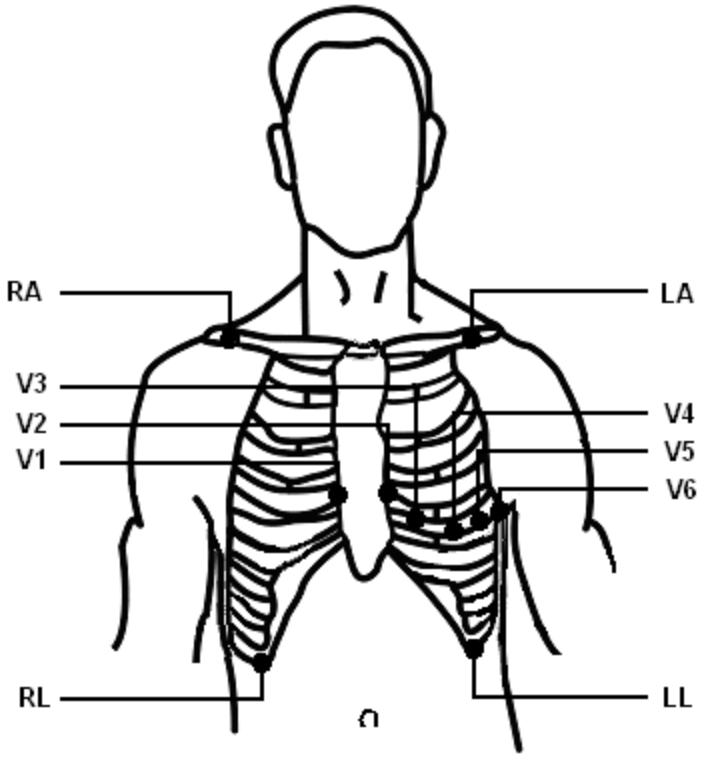
RA (White/White): On or just below the clavicle bone avoiding muscular areas.

***LA (Black/White)*:** On or just below the clavicle bone avoiding muscular areas.

RL (Green/White): On or below the ends of rib cage avoiding flabby areas and the belt.

***LL (Red/White)*:** On or below the ends of rib cage avoiding flabby areas and the belt.

Precordial Lead Placement



***V1 (Red/Brown)*:** Fourth intercostal place at the right margin of the sternum.

***V2 (Yellow/Brown)*:** Fourth intercostal place at the left margin of the sternum.

***V3 (Green/Brown)*:** Midway between V2 and V4 (on top of the 5th rib).

***V4 (Blue/Brown)*:** Fifth intercostal place at the left midclavicular line.

***V5 (Orange/Brown)*:** At the horizontal level of V4, at the anterior axillary line.

***V6 (Purple/Brown)*:** At the horizontal level of V4, at the midaxillary line.

Connecting Electrodes

CAUTION: Use only Ag/AgCl (silver-silver/chloride) snap type electrodes designed for Stress monitoring. Electrodes must comply with the AAMI/ANSI EC-12 Disposable ECG Electrode standard.

CAUTION: Do not mix electrode types. Use only electrodes of similar type. Electrodes of dissimilar metals can cause excessive offsets and may interfere with correct operation of the ECG module.

- Connect the lead wire of the ECG module to the appropriate electrode site with the snap-on lead wires. Ensure that each connection is secure.

- Loop the lead wire once to create a stress loop. Tape the loop to the patient's skin and ensure that there is no tension between the lead wire and the electrode connection.

- If the lead wires are too long, tape them down so that they do not move around during exercise. Lead wire movement can potentially degrade the quality of the ECG tracing during exercise.

- Using the ECG module pouch, attach the ECG module to the handrail of the treadmill or around the patient's waist with the belt provided.

- Verify the quality of the ECG tracings on the *Hookup* screen. When satisfied with the quality of the ECG tracings, click **Stage Up (F4)** to start the Pre-Exercise phase.

- The phase status indicator in the *Hookup* screen will indicate *Learning* and the message prompt will read *Learning ECG please wait* The software requires approximately 30 seconds to learn the ECG signal.

- Once complete, the program will automatically enter the pre-exercise phase of the test and display the initial average beats.

C. Pre-Exercise Phase Operation

During the Pre-Exercise phase, the following operations are typically performed:

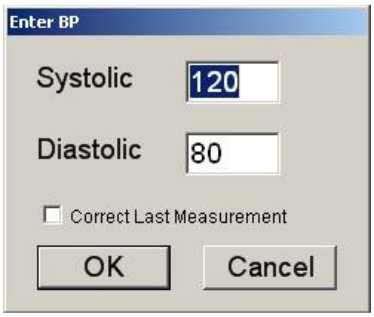
1. Obtain and enter a supine blood pressure (BP) measurement (optional).
2. Acquire a resting ECG report (optional).
3. Acquire a supine rhythm strip.
4. Acquire and enter a standing BP measurement.
5. Prepare the patient for exercise.
6. Acquire a standing rhythm strip, save it and start the treadmill.

The above sequence of pre-exercise actions is typical but may not be the exact sequence performed at the facility. If this is the case, the user may customize the software to meet you requirements as described in *Section II-E, Configuration Settings*.

The IQstress® test has been designed to create a patient baseline during the Learning Phase. Patients with abnormal or irregular heartbeats may have difficulty or may not be able to pass the Learning Phase of the stress test. These patients may not be suitable for the stress test.

Enter Blood Pressure Measurements

Click **Enter BP (F5)** to display the *Enter BP* dialog box and enter the systolic and diastolic blood pressure.

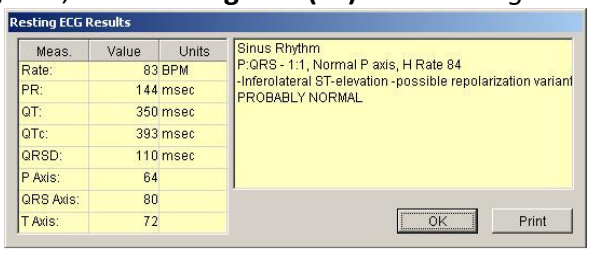


If entering three digits in the *Systolic* edit box, the cursor automatically jumps to the *Diastolic* edit box so the user can continue to enter data. If entering only two digits in the *Systolic* edit box, press the *Tab* key and enter the diastolic BP. If BP requires correction, click the Correct Last Measurement box and enter the correct BP. Click **OK (Enter)** to enter the BP into the report.

Save the Resting ECG Report

To acquire a resting ECG report, the electrode positions should be positioned as indicated in *Section III-B, Patient Preparation*. If using the exercise limb lead placement for the resting ECG, please recognize the fact that this placement will distort the ECG by shifting the axis to the right, increasing the voltage in the inferior lead group. This may cause Q waves to disappear for patients with documented Q-wave inferior myocardial infarction.

To acquire the resting ECG, click **Resting ECG (F9)**. The *Resting ECG* dialog box appears:



Re-acquire the resting ECG report as many times as needed during pre-exercise. The software will overwrite the previous report.

Click **Print** in the *Resting ECG* dialog box to print the resting ECG report. Click **OK** to close the dialog box and proceed with Pre-Exercise phase operations.

Move the limb electrodes from the resting ECG position (limb extremities) to the torso positions for the Exercise phase. Wait for the ECG tracing in the real time display area to stabilize before proceeding.

Acquire the Supine Rhythm Strip

Click **Stage Up (F4)** to acquire the supine rhythm strip and proceed to the Standing stage of the Pre-Exercise phase. Pressing **Stage Up (F4)** automatically saves a rhythm strip for the Supine stage.

Prepare the Patient for Exercise Test

Have the patient stand up. Obtain and enter a BP measurement.

If the patient is not familiar with a treadmill Stress test, explain the procedures.

If the medical treadmill is equipped with a Stop Tether lanyard, the patient must always wear the Stop Tether lanyard wrist strap before operating the treadmill and throughout the entire testing procedure.

Have the patient stand on the treadmill with his or her feet placed to either side of the treadmill belt. Do not stand on the belt prior to starting the treadmill.

Click **Stage Up (F4)** to start the treadmill. The software will save the rhythm strip for the Standing stage prior to starting the treadmill. A confirmation to start will appear:

Click **Yes (Enter)** to start the treadmill.

Have the patient step onto the moving treadmill belt to begin exercise.

The test phase will automatically change to the exercise phase and the software will execute the pre-programmed exercise protocol.

Cautionary Notes for Treadmill Testing

Thoroughly read the owner's manual included with the medical grade treadmill that will be used prior to operating it. Each user should be familiar with the safety features and operation of the treadmill and always exercise the following precautions:

- If the treadmill has a Stop Tether lanyard, the wrist strap must be attached to the patient's wrist before operating the treadmill and throughout the entire test procedure.

- Never start the treadmill with the patient standing on the belt. Always have the patient straddle the belt, then start the treadmill and verify that the belt starts at an acceptably safe speed. Have the patient step onto the slowly moving belt.

- Never allow the patient to step off the treadmill while the belt is moving or the elevation is changing.

- The patient should hold onto the side handrails, but should not grasp the rail tightly as this will cause fatigue and introduce muscle artifact into the ECG signal.

  NOTE: The treadmill may come with front and side handrails. Gently holding to the side handrails has demonstrated less motion artifact than holding on to the front handrail.

- The patient should walk in an upright position and take long easy strides.

- Ensure that the ECG module cable is clear of the patient's legs and the treadmill apparatus.

- If the patient is unfamiliar with using a treadmill, demonstrate the correct walking technique during the Pre-Exercise phase as follows:
  1. Click on **Start Treadmill** (F1) to start the treadmill at the minimum speed of 0.5mph.
  2. Step onto the slowly moving treadmill belt and demonstrate the proper walking technique.
  3. If needed, increase the treadmill belt speed by clicking **Faster (right arrow)**.
  4. Stop the treadmill belt and prepare the patient for exercise.

- If the treadmill speed for the first stage of exercise is too fast for the patient, start the patient at a lower speed during the Pre-Exercise phase using the manual treadmill controls, then click **Stage Up (F4)** to start the exercise protocol.

D. Exercise Phase Operation

During the Exercise phase, the software:

- Analyzes the patient's ECG
- Updates HR and ST measurements on the screen
- Controls the treadmill according to the pre-programmed exercise protocol
- Calculates average beats, performs ST level and slope measurements based on the calculation and saves the measurements as part of the report.
- Stores ECG rhythm strips at pre-programmed times during each test stage

The average beats, ST measurements and rhythm strips will be available for review after the test is completed and the report has been stored in the database.

The typical activities during the Exercise phase consist of:

1. Monitor the patient for changes in HR, ECG, ST segment and blood pressure.
2. Measure and enter BP.
3. Print and/or save rhythm strips (optional).
4. Terminate exercise and enter the recovery phase.

Measure and Enter Blood Pressure

After measuring the blood pressure, click **Enter BP (F5)** and enter the measurement into the dialog box as described in *Section III-C, Pre-Exercise Phase Operation*.

Enter the BP at any time during the Exercise phase.

Manual Treadmill Control

The software automatically controls the treadmill and changes the speed and grade according to a pre-programmed exercise protocol (i.e., Bruce protocol). Manually control the treadmill speed and grade as well as change the exercise stage to increase or decrease the work level.

Control the treadmill speed or grade with the following commands:

- **Slower (left arrow)** decreases the treadmill belt speed by 0.1 mph.
- **Faster (right arrow)** increases the treadmill speed by 0.1 mph.
- **Lower (down arrow)** decreases the grade by 0.5%.
- **Higher (up arrow)** increases the elevation by 0.5%.
- **Stage Up (F4)** advances to the next exercise stage, causing the treadmill speed and grade to change to the settings for the next stage.

- **Stage Down (F2)** retreats to the previous exercise stage, decreasing the treadmill speed and grade according to the exercise protocol in use.
- **Stage Hold (F3)** prevents the software from advancing to the next stage when the stage timer expires.
    - When pressed, the button label changes to **Stage Release**. The treadmill speed and grade will remain at the current settings until one of the following actions is performed:
        - Click **Stage Release (F3)**
        - Click **Stage Down (F2)**
        - Click **Stage Up (F4)**
        - Enter the Recovery phase by clicking **Recovery (F9)**

NOTE: There is an auto **Stage Hold** feature. When one of the following treadmill commands (keys) is pressed, the software automatically enters **Stage Hold** state:

- **Slower** (left arrow)
- **Faster** (right arrow)
- **Lower** (down arrow)
- **Higher** (up arrow)

Stopping and Starting the Treadmill

When the treadmill is running, **Start/Stop Treadmill (F1)** indicates *Stop Treadmill*, indicating that pressing it will immediately stop the treadmill. The treadmill belt will stop but the elevation will remain at its current setting.

While the treadmill is stopped the speed indicator will show zero and grade displays will show the current grade.

Start the treadmill again by clicking **Start Treadmill (F1)**.

CAUTION: When the treadmill resumes, it gradually increases to the current setting; care must be taken to ensure patient safety. Never start the treadmill with the patient standing on the treadmill belt. Have the patient stand on the treadmill and straddle the treadmill belt. Start the treadmill then allow the patient to step on the belt once it starts to move.

Emergency Stop

The treadmill should be equipped with a mechanical stop button for use in emergency situations, usually a red button labeled *Stop* or *Emergency Stop* that is mounted on or near the treadmill. Use the emergency stop button only in emergencies. The normal method of stopping the treadmill is by using **Stop Treadmill (F1)**.

NOTE: The Trackmaster® TMX428 treadmill is equipped with an emergency stop button (ESB). To stop the treadmill during an emergency, press the big red button. The treadmill belt will stop but the incline grade position will remain the same. The treadmill is not operational while the ESB is in the down position.

To release the ESB from the stop position, turn the red knob clockwise until it pops up. The treadmill will automatically reset itself to 0% grade once the ESB is released.

NOTE: The Trackmaster® TMX428 is equipped with an ESB as well as a Stop Tether lanyard (see image below) that the patient wears on the wrist during testing. If the Stop Tether lanyard is pulled, the treadmill belt will stop and lock to prevent slipping for approximately 3 minutes. The treadmill belt will stop but the incline grade position will remain the same. The treadmill will not be operational until the C-shaped clip of the Stop Tether is restored to the small red stop button. The treadmill will automatically reset itself to 0% grade once the Stop Tether lanyard is replaced.

Stop Tether lanyard attached to patient.

NOTE: The IQstress® software will continue to display the patient's ECG as long as the patient is still hooked up to the ECG. The user may continue to monitor, save, print the ECG, proceed to the Recovery phase, or exit the test.

Printing and Saving Rhythm Strips

Click **Print Scrn (F7)** to print a 10-second, 30-second or continuous rhythm strip. The format of the printout is determined by the *Report Settings* in the *User Profile Settings*. All rhythm strip printouts will include the last ten seconds of ECG and will be saved as part of the final report.

Save 12 Ld/Print 12 Ld (F6) saves, or prints and saves, depending on the *Report Settings* in the *User Profile Settings*, the last ten seconds of ECG as part of the report. The *12Ld* ECG is printed in 12 lead + 1 rhythm lead format and can be printed during and after the test.

Ending Exercise

Click **Recovery (F9)** when it is time to end the Exercise phase of the test. The treadmill belt will come to a gradual stop and the treadmill will return to 0% elevation if the Regular Stop in the Recovery phase was selected in Profile Settings. If there is a cool down stage or gradual stop programmed for the Recovery phase, the treadmill speed and grade will automatically change to the preprogrammed settings.

> **NOTE:** If the Stop Belt option was selected in the Recovery phase setting, the treadmill belt will stop quickly without changing its elevation. Use this setting only for stress echo procedure.

The phase display will indicate *Recovery*.

> **NOTE:** Once in the Recovery phase, it is not possible to return to the Exercise phase. Be careful not to click **Recovery (F9)** inadvertently.

If **Recovery (F9)** is clicked on by accident but want the patient to continue exercising, manually set the treadmill speed and grade during the Recovery phase. Click **Start Treadmill (F1)** and adjust the speed and grade as described above.

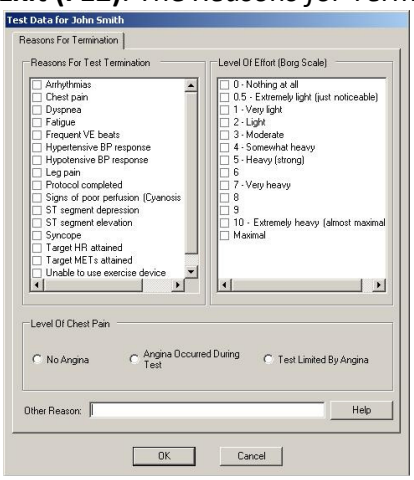
E. Recovery Phase Operation

During the Recovery phase, the software continues to perform average beat calculations and stores average beats and timed rhythm strips. Operations during the Recovery phase are similar to the Exercise phase, except that the patient is in a supine position.

The typical activities during the Recovery phase are:

1. Monitor the patient for changes in HR, ECG, ST segment and blood pressure
2. Measure and enter BP
3. Print rhythm strips (option)
4. Terminate the Stress test and save the report

To end the Stress test, click **Exit (F12)**. The *Reasons for Termination* dialog box appears:



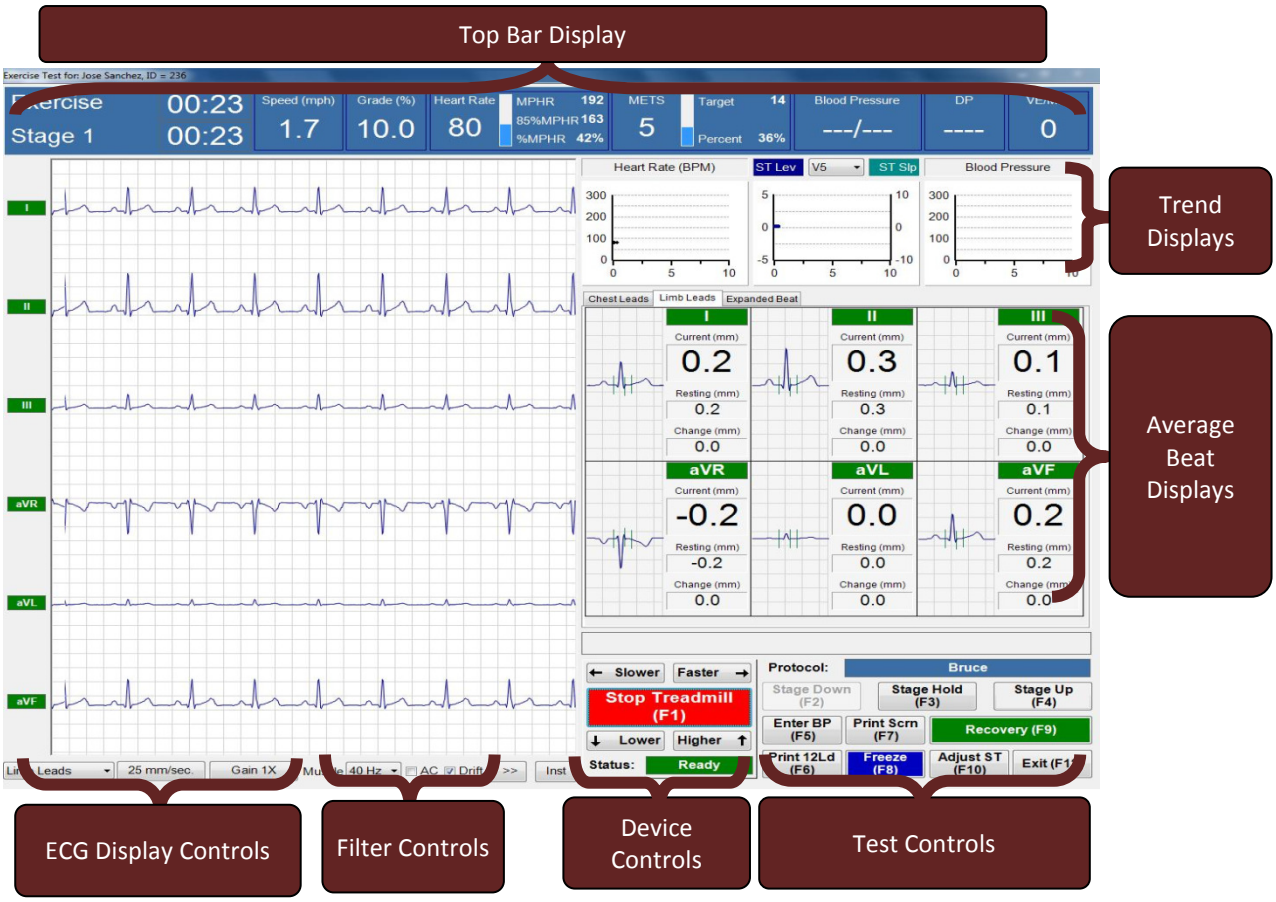
Enter the reason(s) for stopping the test checking the box next to an item from the *Reasons for Test Termination* list. If 'reason' is not included in list, enter text into Other Reason box.

Ask the patient to rate the perceived exertion and check an item in the *Level of Effort (Borg Scale)* list.

Ask the patient about chest pain experienced during the test and select one of the choices in the *Level of Chest Pain* control group. This information is required to calculate the Duke Treadmill Score.

Click **OK** to exit the *Exercise Test* screen and save the test. Click **Cancel** to close the above dialog box and remain in the *Exercise Test* screen.

Exercise Test Screen Displays and Controls



Top Bar Display

The upper portion of the *Exercise Test* Screen displays test phase information, exercise level, heart rate, METS, blood pressure and VE/min.

Test Phase Information

The *Test Phase Information* display shows the name of the phase (Hookup, Pre-Exercise, Exercise or Recovery), the phase time in minutes and seconds, the stage name and the stage time in minutes and seconds.

If the current test phase does not have any stages, then the *Stage Name* display area will be blank and the *Stage Time* display will not update.

The phase time and stage time increment once per second.

Exercise Level Information

The *Exercise Level* display area displays the current treadmill speed and grade.

- For pharmacological Stress tests, this area displays the current dosage and dosage units.

The software updates the exercise level information automatically when the exercise stage changes or when the exercise level is manually changed.

Heart Rate Display

The *Heart Rate* display shows the current heart rate, the target heart rate, percentage of the target heart rate and a progress bar that represents the percentage of the target heart rate.

The software updates the *Heart Rate* display once per second. The heart rate calculation is based on sliding window of the previous eight beats.

METS Display

The *METS* display shows the current exercise level in METS, the target METS, the percentage of the target METS and a progress bar. See Section XV, Appendix C – METS Calculations for additional information.

Blood Pressure and Double Product (DP)

The *Blood Pressure* display shows the last entered blood pressure value as systolic over diastolic. If no BP measurement has been entered, the display indicates ---/---.

The software automatically updates the *Double Product (DP)* display when a new BP measurement is entered. The DP (also called rate pressure product) displayed is the systolic BP times the current heart rate divided by 100.

The color of the BP and DP displays changes to yellow if the displayed BP measurement is older than 90 seconds.

VE/Min Display

The *VE/Min* display shows the number of ventricular ectopic beats in the last sixty seconds. This display is updated once per second.

ECG Display Controls

The *ECG Display Controls* configure the displayed lead groups, change the sweep speed and change the display gain of the ECG.

Lead Group Selection

The displayed leads in the ECG tracing area are changed by using the *Lead Selection* list in the lower left-hand corner of the screen. Select an item from the drop-down list and the display will automatically update.

When switching from chest leads to limb leads, the software also changes the displayed leads in the average beat display area to match the ECG tracing area.

There are several key combinations that can be used to quickly change the displayed leads quickly.

Lead Selection Shortcut Key Combinations		
Shortcut Key	**Real Time Display**	**Average Beat Display**
Alt + C	Chest leads	Chest leads
Alt + L	Limb leads	Limb leads
Alt + A	All leads	No change
Alt + R	Rotates to the next lead group	No change
Alt + E	No change	Shows the expanded average beat for the last selected lead.

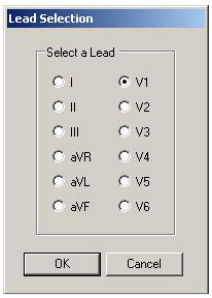
Note: The up and down arrow keys are dedicated to controlling treadmill elevation and cannot be used to select lead groups from the drop-down list.

Individual Lead Selection

It is possible to display any ECG lead in the display area of any channel in the scrolling display area of the *Exercise Test* screen. This feature allows the user to align ECG leads in ways that are not available from the standard lead group selections.

To assign an ECG lead to a display channel position, click on the green lead label located to the left of the display channel in the scrolling display area and the *Lead Selection* dialog box opens. Select the lead to display then click **OK**.

The new lead selection will remain in effect until lead groups are changed or the exercise test is terminated.



Sweep Speed

Next to the *Lead Selection* drop-down list, the *Sweep Speed Selector* rotates the sweep speed of the ECG tracing area to one of the following sweep speeds:

- 12.5 mm/sec.
- 25 mm/sec. (default)
- 50 mm/sec.

Clicking on the button or pressing **Alt + S** rotates through the available sweep speeds.

Changing the sweep speed of the ECG tracing area does not affect the display characteristics of the average beats.

Gain Setting

The *Gain* setting rotates the display gain for both the ECG tracing area and the average beats. The gain settings are

- Gain 1/2X (5 mm/mv)
- Gain 1X (10 mm/mv)
- Gain 2X (20 mm/mv)

Clicking on the button or pressing **Alt + G** rotates through the available gain settings.

Filter Controls

The *Filter* option controls the Muscle, AC and Drift filters. There are three options for the Muscle filter: *Off*, *20Hz* and *40Hz*. The AC and Drift filters have the option of being *On* or *Off*.

NOTE: The AC filter setting is inactive until the software has calculated the average beats.

NOTE: When using the Muscle filter, the AC filter is not required and should be turned off.

Exercise Device Controls

Device Controls		
Button	**Keyboard Key**	**Description**
Start Treadmill/ Stop Treadmill	F1	Starts the treadmill at the current speed setting if the button label indicates *Start Treadmill*. Stops the treadmill if the button label indicates *Stop Treadmill.*
Slower	← (Left Arrow)	Reduces the treadmill speed by 0.1 MPH (or 0.1 KPH) if the treadmill is running.
Faster	→ (Right Arrow)	Increases the treadmill speed by 0.1 MPH (or 0.1 KPH) if the treadmill is running.
Lower	↓ (Down Arrow)	Decreases the treadmill grade by 0.5% if the treadmill is running.
Higher	↑ (Up Arrow)	Increases the treadmill grade by 0.5% if the treadmill is running.

NOTE: There is an auto **Stage Hold** feature. When one of the following treadmill commands (keys) is pressed, the software automatically enters **Stage Hold** state:

- **Slower** (left arrow)
- **Faster** (right arrow)
- **Lower** (down arrow)
- **Higher** (up arrow)

Manual Treadmill Control during Hookup or Pre-Exercise

Manually control the treadmill during Hookup or Pre-Exercise phases in order to restore the grade to zero or to demonstrate proper walking technique to a patient that is not familiar with walking on a treadmill, among other reasons.

Click **Start Treadmill (F1)** and the treadmill will start at the minimum speed setting (0.5mph). Use the treadmill speed and grade controls to adjust the speed and/or grade of the treadmill.

NOTE: Be sure to stop the treadmill before starting the Exercise test.

Manual Treadmill Control during Exercise

During the Exercise phase, the software automatically controls the treadmill during execution of the pre-programmed exercise protocol.

To stop the treadmill during exercise, click **Stop Treadmill (F1)**.

To restart the treadmill, click **Start Treadmill (F1)**.

CAUTION: The treadmill will start at the displayed speed settings; never start the treadmill while the patient is standing on the treadmill belt.

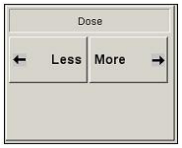
Treadmill Status Indicator

The treadmill *Status* display is located at the bottom of the screen. When the treadmill is connected and operating correctly the *Status* display will indicate *Ready*.

If the status display indicates *Disconnected*, check the treadmill's power cable and that the power is on. Also check the connection between the treadmill and the computer. If still experiencing difficulties, see *Section XV-Appendix A, Troubleshooting IQstress®*.

Pharmacological Controls

If performing a pharmacological procedure (such as Dobutamine) the treadmill controls will be replaced with the following:



Less (left arrow) reduces the *Dose* indication by one unit; **More (right arrow)** increases the *Dose* indication by one unit.

NOTE: These controls apply to the Dose display, NOT a drug delivery device.

Test Controls

Test Controls		
Button	**Keyboard Key**	**Description**
Stage Down	F2	Returns to the previous protocol stage. The software adjusts the treadmill speed and grade automatically.
Stage Hold/ Stage Release	F3	Places and releases a stage hold mode on the treadmill control logic. The button label rotates with each click. The treadmill remains at the current stage until onf of the following buttons are clicked; **Stage Release**, **Stage Down** or **Stage Up**.
Stage Up	F4	Advances the protocol to the next stage. The software automatically changes the treadmill speed and grade.
Enter BP	F5	Displays the *Enter BP* dialog box so the user can enter a new blood pressure reading.
Save 12Ld/ Print 12Ld	F6	Saves or prints the last ten seconds of ECG as a rhythm strip in the report, using 12 lead plus 1 rhythm lead format, as defined in the Report Settings in the User Profile Settings.

Test Controls		
Button	**Keyboard Key**	**Description**
Print Scrn	F7	Prints and saves a 10-second, 30-second or continuous rhythm strip. Printout format is determined by the *Report Settings* in the *User Profile Settings*. All rhythm strip printouts will include the last ten seconds of ECG and will be saved as part of the final report.
Freeze/ Unfreeze	F8	Displays and closes the *Freeze Display*. The button label rotates with each click.
Recovery	F9	Stops the treadmill and starts the Recovery phase. If there is a cool-down stage programmed for the Recovery phase, the treadmill speed and grade will automatically change to the preprogrammed settings.
Adjust ST	F10	Displays a dialog that allows the user to adjust the ST reference points for the average beats.
Exit	F12	Ends the test and saves the report.

Freeze Display

The *Freeze Display* has a full-disclosure feature that allows the user to review the previous ECG data going all the way back to the beginning of the Pre-Exercise phase.

Click **Freeze (F8)** to view the *Freeze Display*.

The upper-portion of the *Freeze Display* shows the phase name, phase time, stage name and stage time. The information will change as the slide bar at the bottom of the screen is moved. The ECG data for that phase and stage time will be shown at the top of the screen. Use the **Previous** ( ) and **Next** ( ) buttons to fine tune the ECG to review. Depending on the screen size and resolution, clicking the or button allows moving backward or forward –four to six seconds.

- Click on the **Refresh** ( ) button to update the *Freeze Display* with the most recent ECG data.
- Click on the **Print** ( ) button to print and save a rhythm strip containing the ECG displayed in the *Freeze Display*.
- Click on the **Save** ( ) button to save a rhythm strip containing the ECG displayed in the *Freeze Display*.

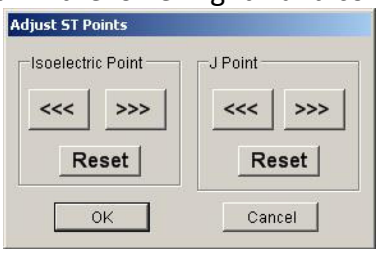
The vertical scroll bar allows the user to display all 12 ECG leads.

Hide the *Freeze Display* by clicking **Hide** ( ) or **Unfreeze (F8)**.

Freeze Display Controls	
Control	**Description**
Slide Bar	Quickly moves to different phases and stages.
Previous ( )	Displays the previous four to six seconds of the ECG.
Next ( )	Displays the next four to six seconds of the ECG.
Refresh ( )	Updates the *Freeze Display* with the most recent ECG data.
Hide ( )	Hides the *Freeze Display.*
Print ( )	Prints and saves a rhythm strip containing the ECG displayed in the *Freeze Display.*
Save ( )	Saves a rhythm strip containing the ECG displayed in the *Freeze Display*.

Adjusting ST Reference Points

Click **Adjust ST (F10)** to adjust the ST reference points for the average beats. The Adjust ST Points dialog box will appear in the lower right-hand corner of the display.



- Use **<<<** to move the isoelectric or J Point to the left of its current position.
- Use **>>>** to move the isoelectric or J Point to the right of its current position.
- **Reset** restores the reference points to their original positions.

Click **OK** to accept the new reference point positions or **Cancel** to ignore the changes.

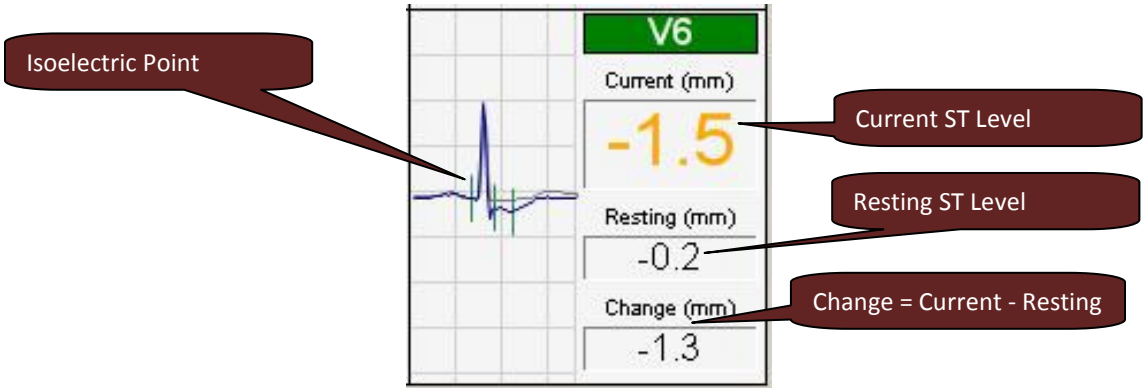
Average Beat Display

The *Average Beat Display* shows the average beats for six leads at a time. Toggle between the chest leads and the limb leads by clicking on the *Chest Leads* tab or the *Limb Leads* tab just above the average beat waveform display area.

To zoom in on an individual lead, click the waveform of an average beat. The expanded average beat display will appear.

When selecting a lead for the expanded average beat, the software also changes the trend display to show the ST level and slope trends for the selected lead.

Single Average Beat Display



Each *Average Beat* window shows the current average beat in blue superimposed on the resting average beat in gray. The display also indicates the isoelectric point, J point and ST measurement point for the current average beat.

If the ST segment slope is horizontal or down-sloping, the *Current ST Level* display is color-coded:

- If the change in ST depression is less than 1.0 mm, the display characters are black.
- If the change in ST depression is between 1.0 mm and 2.0 mm, the display characters are orange.
- If the change in ST depression is greater than or equal to 2.0 mm, then the display characters are red.

Expanded Average Beat Display

The *Expanded Average Beat Display* shows the same information as the *Average Beat Display* for a single lead, as well as the current, resting and change in ST slope. The current ST level display is color-coded similarly to *Single Average Beat Display*.

To return to the *Average Beat Display*, click on the waveform area or click on the *Chest Leads* or *Limb Leads* tabs to show the *Standard Average Beat Display* for the chest leads or the limb leads.

Trend Displays

The *Trend Display* shows trend graphs for the heart rate, ST measurements and blood pressure for the current phase of the test. The horizontal axis represents the phase time in minutes.

The ST measurements trend shows a graph for the ST level and the ST slope. ST level is plotted against the left axis and ST slope is plotted against the right axis of the trend. The graphs are plotted in different colors.

Change the lead selection for the ST measurement trend by selecting a lead from the drop-down list located above the ST measurement trend.

The software also changes the ST measurement lead selection when selecting an ECG lead for viewing in the expanded average beat view by clicking on the waveform area of an *Average Beat Display*.

IV. Review and Edit Operations

A. Overview

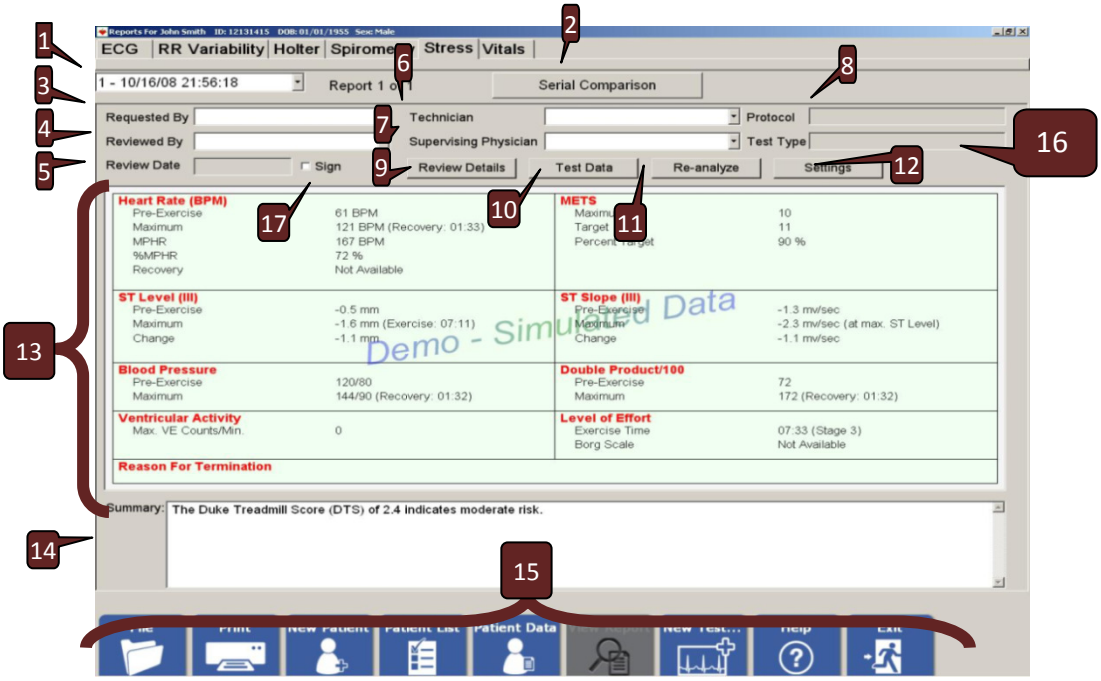
Upon completion of a Stress test, the software displays the *Review and Edit* screen showing a summary of the test results and allowing the user to do the following functions:

- View and edit the report
  - View the test summary and edit the results
  - View all stored average beats and delete noisy beats from the report
  - View all stored rhythm strips
  - View tabular and trend data
  - View the resting ECG report and edit the interpretation
- Clicking **File** or **Print** allows the user to:
  - Print or print preview the report
  - Fax or email the report
  - Save the report to a file

Refer to the *IQmanager® Operation Manual* for information on **File** and **Print**.
The review and edit screens are comprised of the following:

- ***Summary Review:*** view and edit the test summary and results.
- ***Average Beat:*** view and delete average beats stored with the report.
- ***Summary Table:*** view a spreadsheet-style summary of HR, ST, BP, exercise level and other measurements.
- ***Trend:*** view trends for the HR and the ST level and slope for all twelve leads.
- ***Resting ECG:*** view the resting ECG report, including the interpretation.
- ***Rhythm Strip:*** view all of the rhythm strips stored in the report.

Summary Review Screen

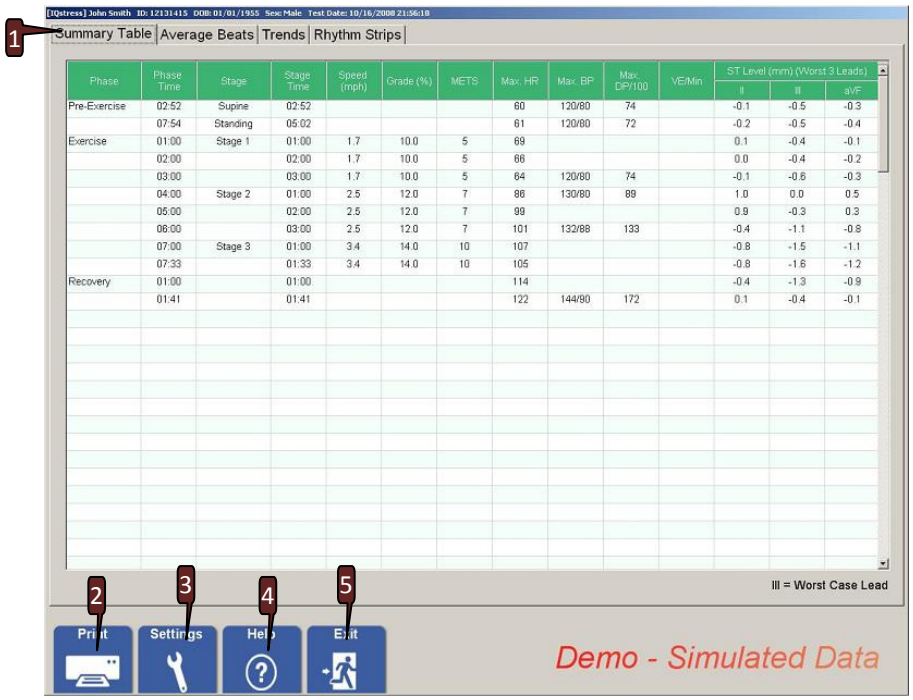


This screen shows summary test results that appear on the printed *Cover Page* of the report. Edit the interpretation or test data, reanalyze or print the report or display the *Review Details* screen to view more detailed data, from this screen.

Summary Review Screen Controls			
#	Control/Display	Type	Description
1	**Report Selector**	Drop-Down List	Displays the date and time of report and allows the user to select another report from a drop-down list.
2	**Serial Comparison**	Button	Opens a dialog box to select Stress reports for viewing or printing the Serial Comparison Report.
3	**Requested By**	Drop-Down List	Select the name of the physician that requested the test from the drop-down list or type in a name.
4	**Reviewed By**	Drop-Down List	Select the name of the reviewing physician from the drop-down list or type in a name.
5	**Review Date**	Static Text	Displays the date on which the report was reviewed.
6	**Technician**	Drop-Down List	Select the name of the technician that conducted the test from the drop-down list or type in a name.
7	**Protocol**	Static Text	Displays the exercise protocol used.
8	**Supervising Physician**	Drop-Down List	Select the name of the physician that supervised the test from the drop-down list or type in a name.
9	**Review Details**	Button	Displays the *Review Details* screen.
10	**Test Data**	Button	Displays the *Test Data* dialog box to enter the reason for terminating the test, the Borg scale and the level of chest pain.

Summary Review Screen Controls			
#	Control/Display	Type	Description
11	**Re-analyze**	Button	Re-analyzes the test results based on changes to the patient data and/or to the report data. **NOTE:** If a report is re-analyzed, the software will overwrite any changes that were made to the interpretation text.
12	**Settings**	Button	Displays the *IQstress Settings* dialog box to change the configuration settings, create and edit exercise protocols and create and edit user profiles.
13	**Summary Display**	Static Text	Displays a summary of test results, which appears on the *Cover Page Report*.
14	**Summary**	Edit Box	Enter a conclusion or interpretation of the test results.
15	**IQmanager Controls**	Buttons	Perform various file, print and save operations. Refer to the *IQmanager® Operation Manual* for a description of these controls.
16	**Test Type**	Static Text	Displays the type of exercise used for the test: *Treadmill* or *Pharmacological*.
17	**Sign**	Check Box	The *Sign* checkbox is used for signing off the report. If the *Sign* checkbox is unchecked, it indicates the report has not been signed by a physician and can still be edited. If the *Reviewed By* box is filled in with a physician's name and the *Sign* checkbox is checked and saved when the review screen is exited, the report becomes read-only.

B. Review Details Screen



Review Details Screen: Summary Table

The *Review Details* screen allows the user to select and view the following reports:

- Summary Table
- Average Beats
- Trends
- Rhythm Strips
- Resting ECG (available only if a resting ECG analysis was performed during the Pre-Exercise phase of the test)

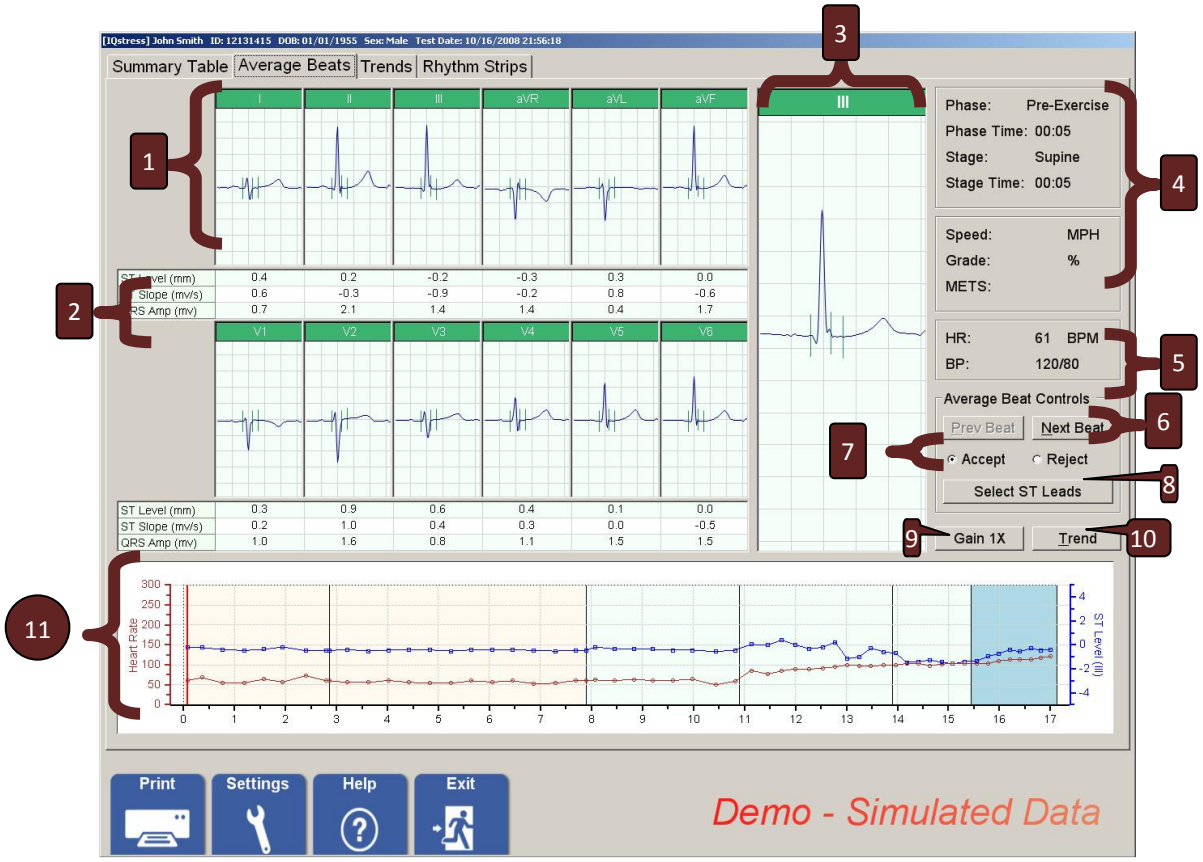
Review Details Screen Controls			
#	**Control/Display**	**Type**	**Description**
1	**Screen Selector**	Tab Control	Select the review screen to view.
2	**Print**	Button	Select from the following choices: • Print the Entire Report • Print the Current Page • Print Preview the Entire Report • Print Preview the Current Page • Page Setup
3	**Settings**	Button	Displays the *IQstress Settings* dialog box to change the configuration settings, create and edit exercise protocols and create and edit user profiles.
4	**Help**	Button	Displays the *Help* screen.
5	**Exit**	Button	Closes the *Review Details* screen and returns to the *Summary Review* screen.

C. Summary Table Screen

The *Summary Table* screen shows the same data as the *Summary Table Report*. See *Section V, Reports*. There is no editable data in this screen.

D. Average Beat Screen

This screen allows the user to view each average beat stored for the report, edit the report by rejecting noisy average beats and automatically generate a new report.



Average Beat Screen Controls			
#	Control/ Display	Type	Description
1	**Individual Lead Displays**	Waveform display	Displays the QRS for each lead of the current average beat.
2	**Measurement Display**	Static Text	Shows the ST level, ST slope and QRS amplitude for each lead.
3	**Expanded Lead Display**	Waveform display	Shows the QRS for a selected lead of the current average beat in an expanded (2X) format. The default view shows the lead with the worst case ST depression; click on the waveform for any lead to show that lead's average beat.
4	**Exercise Status Display**	Static Text	Displays the phase name, phase time, stage and stage time, as well as the treadmill speed and grade for the displayed average beat.
5	**HR/BP Display**	Static Text	Shows the heart rate and blood pressure measurements at the time that the average beat was stored.
6	**Prev Beat/ Next Beat**	Button	Displays the previous/next average beat.
7	**Accept/Reject**	Radio Button	Saves or deletes the displayed average beat.
8	**Select ST Leads**	Button	Displays a dialog box that allows the user to select which leads to use for ST measurements.
9	**Gain**	Button	Displays and edits the gain setting for the waveform display.
10	**Trend**	Button	Displays the *Trend Parameters Selection* dialog box to change the trended parameters.
11	**Trend Display**	Trend Graph	Displays two trended parameters, one plotted against the left vertical axis and one plotted against the right vertical axis against the test time. The default trend parameters are HR on the left axis and the ST level of the worst case lead on the right axis. Click **Trend** to change the trended parameters.

Expanding a Lead

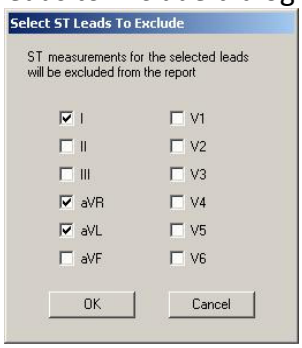
To show a selected lead in the expanded average beat window, **Click** the waveform display window of the desired lead; the trend display will also show the ST parameter for the selected lead.

Rejecting Average Beats

Clean up beats that are consider too noisy by removing it from the report. Click the *Reject* radio button to remove the displayed beat from the report and repeat for all the beats to be removed. The software will re-calculate the ST measurements displayed in the report and produce a new interpretation when the report is saved.

Selecting ST Measurement Leads

The *Average Beat Review* screen has a feature that allows the user to filter out possibly noisy leads to ignore for ST measurement. Click **Select ST Leads** on the *Average Beat Review* screen and the *Select ST Leads to Exclude* dialog box will appear:



Select the ECG leads to exclude and click **OK**.

The software automatically recalculates the reported ST measurements if the ST lead selections are changed and will store the new ST lead selections with the report data. Review and change excluded ECG leads at any time from this screen.

NOTE: Changing the ST lead selections in the Average Beat Review screen does not affect the user profile configuration settings.

Trend Display

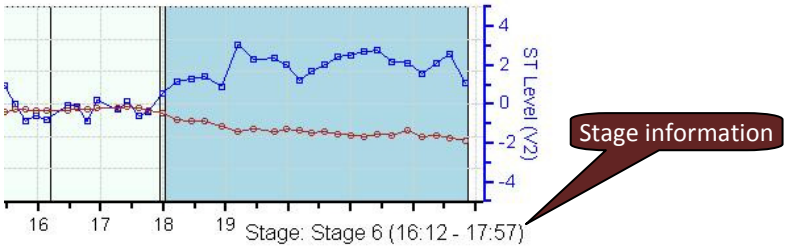
The *Trend* display at the bottom of the *Average Beat Review* screen plots two trended parameters on the vertical axes (left and right) by the test time on the horizontal axis. By default, the software plots the heart rate on the left vertical axis and the ST level of the lead with the worst case depression on the right vertical axis.

Each point on the graph represents a stored average beat. Phases are color-coded:

- The **Pre-Exercise** phase is light **orange**.
- The **Exercise** phase is light **green**.
- The **Recovery** phase is light **blue**.

Vertical lines mark the beginning and ending of each stage within a phase.

Hover the mouse over a point on the graph to display the stage information of that point; the stage information appears in the lower-right corner of the trend display.



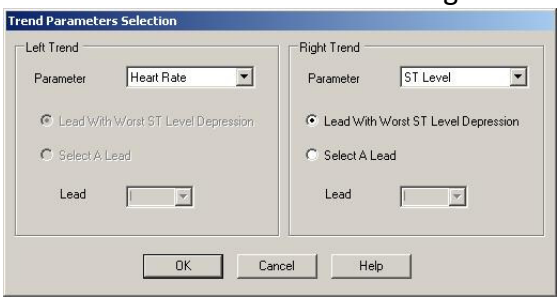
Navigating within the Trend Display

The red vertical marker in the *Trend* display indicates the time of the displayed average beat. There are two ways to use the trend to display a different average beat:

- Click the desired time in the trend display; the software will move the vertical marker and update the average beat displays to show the nearest average beat.
- Click and drag the vertical marker to the time of the average beat that to view then release the left mouse button.

Changing Trended Parameters

Click **Trend** to show the *Trend Parameters Selection* dialog box.

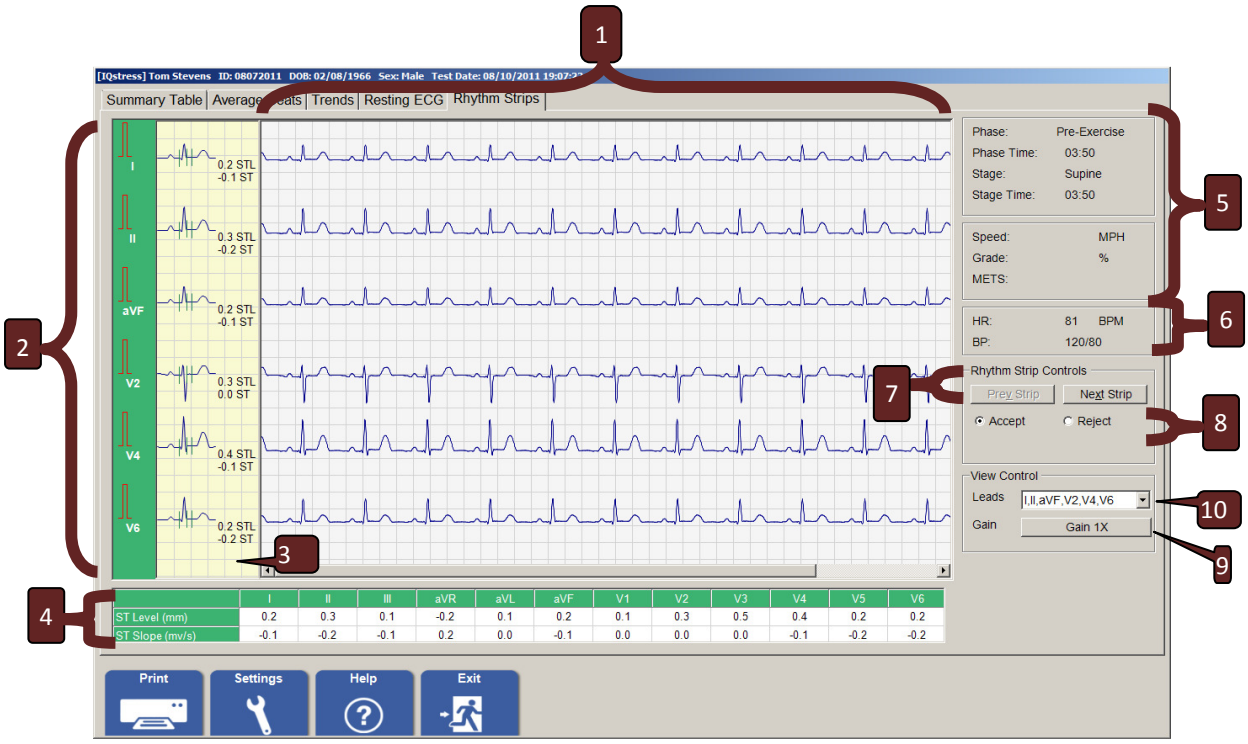


Select the parameters to show from the drop-down lists. The available choices are:

- Heart Rate
- QRS Amplitude
- ST Level
- ST Slope

If selecting ST Level or ST Slope, the user will have the option to display the lead with the worst ST level depression or a selected lead. If checking the *Select A Lead* option, choose the lead in the associated drop-down list. Click **OK** to update the trend display.

E. Rhythm Strip Screen



The *Rhythm Strip* screen allows the user to view all of the rhythm strips stored in the report.

Rhythm Strip Screen Controls			
#	Control/Display	Type	Description
1	**Waveform Display**	Waveform display	Displays the ECG for the selected rhythm strip; zoom in and expand selected portions of the ECG.
2	**Average Beat Display**	Waveform display	Shows the average beat at the time that the rhythm strip was stored. Also shows the ST level (STL) and ST slope (STS) measurement for the average beat.
3	**Splitter Window Control**	Splitter control	Resizes the *Average Beat* display.
4	**Measurement Display**	Static text	Shows the ST level and ST slope for each lead.
5	**Exercise Status Display**	Static text	Displays the phase and time, and stage number and times as well as the treadmill speed and grade at the time that the displayed rhythm strip was stored.
6	**HR/BP Display**	Static text	Shows the heart rate and blood pressure measurements at the time that the rhythm strip was stored.
7	**Prev Strip/ Next Strip**	Button	Displays the previous/next rhythm strip.
8	**Accept/Reject**	Radio button	Saves or deletes the displayed rhythm strip.

9	**Gain**	Button	Displays the current gain setting for waveform display and allows the user to change the gain.
10	**Leads**	Drop-down list	Shows the displayed lead group and allows the user to select the lead group to display. The default is determined by the *Display Leads* setting on the *Misc* tab of the *Configuration* dialog box.

Navigating in the Waveform Area

Perform the following actions on the waveform area to control the display.

- Zoom in to display a selected portion of the waveform in an expanded format: Click the *Waveform* display when the cursor is a magnifying class with a plus sign in the center; the display will magnify the ECG by a factor of two. The cursor will change to a magnifying glass with a minus sign in the center, which allows the user to zoom out.
- Scroll the *Waveform* display by using the horizontal and vertical scroll bars. The vertical scroll bar is present only if the waveform display window is not large enough to contain all of the ECG data, such as when displaying all twelve leads or in an expanded view.
- Pan the *Waveform* display by pressing the **Shift** key while clicking and dragging the mouse up, down, left or right. Release the **Shift** key and the mouse when finished with moving the *Waveform* display.
- Resize the *Average Beat* display by clicking and dragging the splitter window control.
- Select different lead groups to view using the *Leads* drop-down list.

Rejecting Rhythm Strips

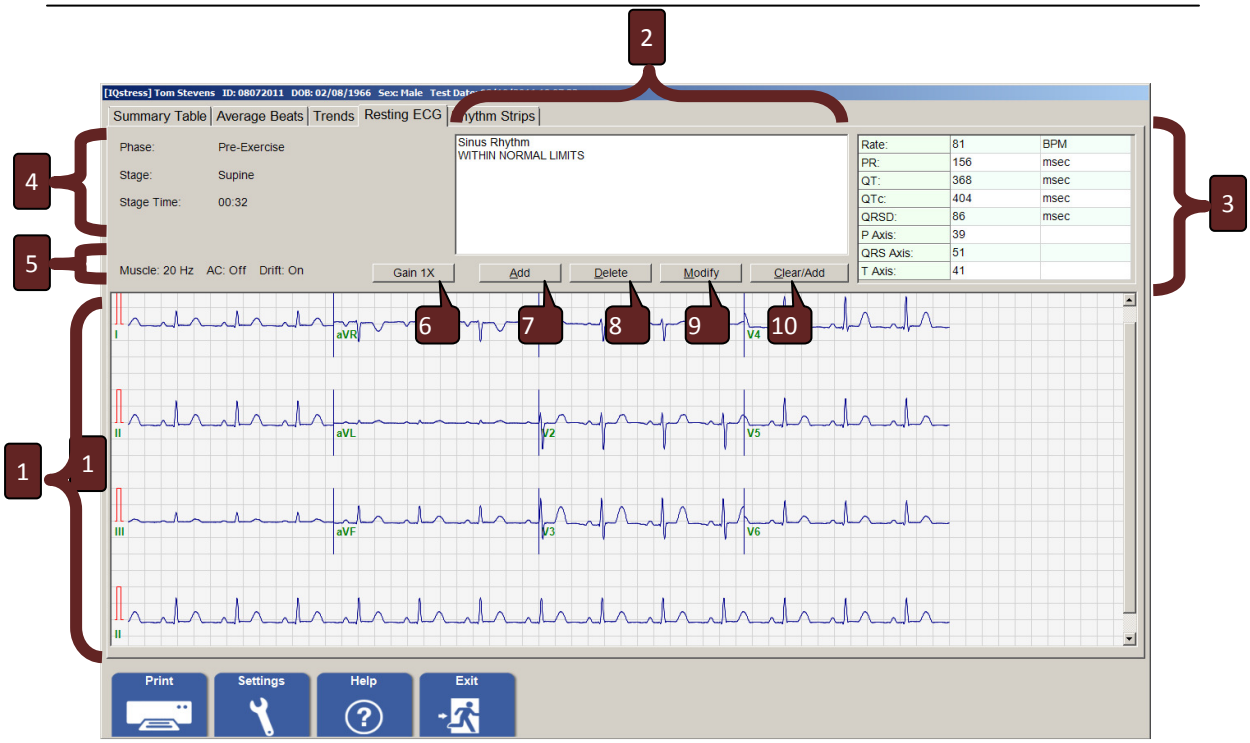
Delete a rhythm strip from the report by selecting the *Reject* radio button; the rhythm strip will be deleted when the report is saved.

Deleting rhythm strips allows the user to reduce the number of pages in the report and/or to remove rhythm strips that contain excessive amounts of noise; it does not affect the ST measurements or the report interpretation.

F. Resting ECG Screen

The *Resting ECG* screen displays the results of the interpretations of the resting ECG that was stored during the Pre-Exercise phase of the Stress test. This screen allows the user to zoom in on selected parts of stored ECG waveforms and to edit the interpretation.

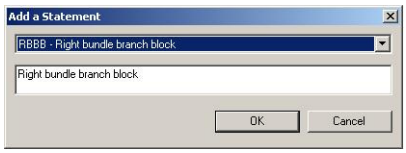
NOTE: The Resting ECG Screen will be visible only if the resting ECG report was stored during the Stress test.



Resting ECG Screen Controls			
#	Control/Display	Type	Description
1	**Waveform Display**	Waveform display	Displays all twelve leads of the ECG stored for the resting ECG report; each lead group displays a different two-second portion of the 10-second sample.
2	**Interpretation Display**	List Control	Displays the interpretation of the resting ECG. Edit by using **Add**, **Delete**, **Modify** and **Clear/Add**.
3	**General Measurements**	Static Text	Displays general measurements for the resting ECG.
4	**Phase and Stage**	Static Text	Displays the phase name, stage name and stage time when the resting ECG analysis was performed.
5	**Muscle, AC, Drift**	Static Text	Displays the status of the filters at the time the resting ECG sample was taken.
6	**Gain**	Button	Displays the gain setting for the *Waveform* display and allows the user to change the gain.
7	**Add**	Button	Displays the *Add a Statement* dialog box to add a statement to the interpretation.
8	**Delete**	Button	Deletes the selected statement from the *Interpretation* display.
9	**Modify**	Button	Displays the *Modify a Statement* dialog box edit a selected statement.
10	**Clear/Add**	Button	Clears the list of interpretative statements and displays the *Add a Statement* dialog box.

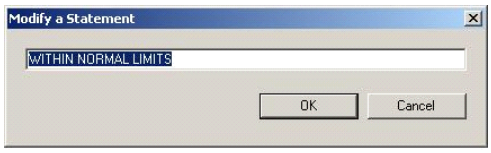
Editing the Interpretation

To add a statement to the list of interpretation statements, click **Add (Alt+A)**. To clear the list of statements and add a new statement, click **Clear/Add (Alt+C)**. The following *Add a Statement* dialog box appears:



Each interpretative statement has an associated abbreviation. Type the first letter of an interpretative statement's abbreviation and the full statement will appear in the drop-down list. Click **OK (Enter)** to add the statement to the list. If the desired statement does not appear immediately, press the first letter again to move to the next available choice. Select from the drop-down list.

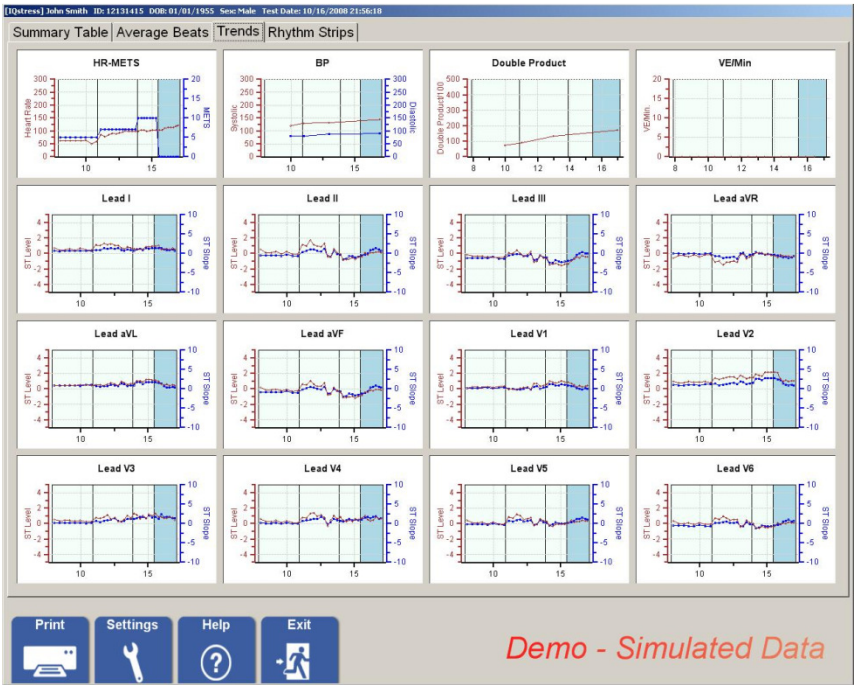
To modify or edit a statement in the interpretation list, select the statement in the list then click **Modify (Alt+M)**. The following *Modify a Statement* dialog box appears:



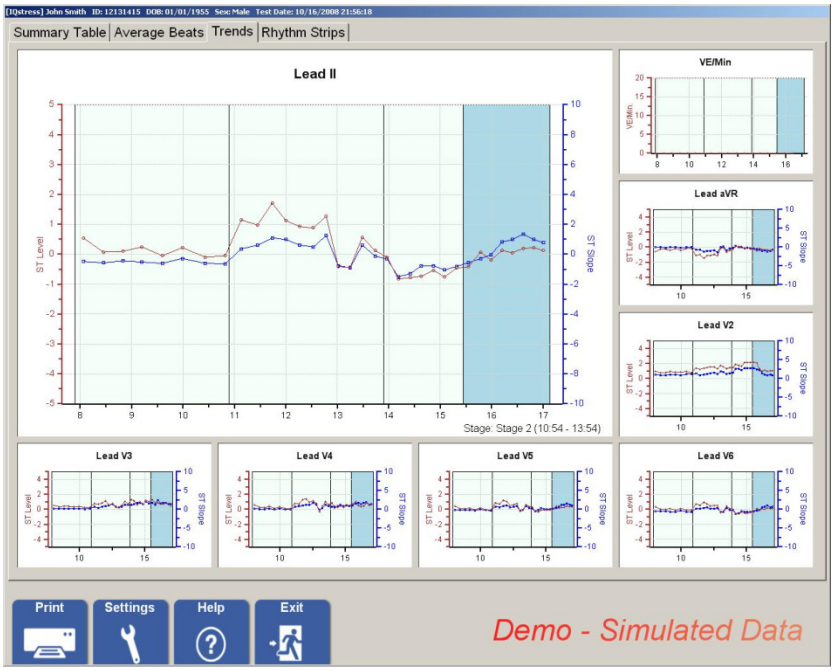
Type a new statement or modify the existing statement, then click **OK (Enter)** to save.

G. Trends Screen

The *Trends* screen displays trend graphs for HR, METS, blood pressure and double product (DP/100), VE/min, ST level and ST slope for each lead.



Zoom on a selected graph by clicking on the desired parameter's window; an expanded view of the trend graph appears. To return to the normal view, click on the expanded trend view.



The trends do not show the data from the Pre-Exercise phase due to the limited display area for each trend.

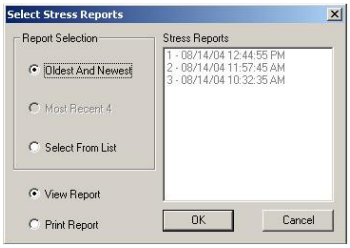
Each phase is color-coded with vertical boundary lines marking each stage. Move the mouse cursor over an area of interest to view its phase and stage time. The stage and/or phase time will appear in the lower-right corner of the trend's window.

H. Serial Comparison

The software provides a serial comparison feature for side by side comparison of two, three or four Stress test reports.

Click **Serial Comparison** on the *Summary Report* screen and the Select Stress Reports dialog box appears:

The *Stress Reports* list shows all of the Stress reports stored in the database. The most recent report appears at the top of the list.



Select *Most Recent 4* to compare the four most recent Stress reports, or select the *Select From List* radio button to select two, three or four reports to compare.

Select *View Report* to view the report on the screen or *Print Report* to print the serial comparison report. Click **OK** to view or print the report.

[Stress Test Serial Comparison Report] John Smith ID: 123 Sex: Male Age: 53
Test No.1
Test No.2
Test Date 10/21/2009 06:11:05 PM 08/28/2009 03:05:27 PM
Protocol Bruce Bruce
Reviewed By
Review Date
Heart Rate
Pre-Exercise 70 BPM 60 BPM
Maximum 118 BPM (Exercise: 04:33) 184 BPM (Exercise: 05:16)
Percent Target 70 % 110 %
Recovery Not Available 184 BPM (0 BPM) Recovery (02:00)
METS
Maximum 11 7
Percent Target 100 % 63 %
ST Level
Max. Lead II V6
Pre-Exercise 0.8 mm 0.1 mm
Maximum -1.5 mm (Exercise: 02:29) 0.0 mm (Exercise: 03:26)
Change -2.2 mm -0.1 mm
ST Slope
Max. Lead II V6
Pre-Exercise -0.7 mv/sec 0.2 mv/sec
Maximum -2.6 mv/sec (at max. ST Level) 0.1 mv/sec (at max. ST Level)
Change -2.0 mv/sec -0.1 mv/sec
Blood Pressure
Pre-Exercise Not Available 156/84
Maximum Not Available 156/84 (Pre-Exercise: 00:20)
Summary The Duke Treadmill Score (DTS) of -6.1 indicates moderate risk. The Duke Treadmill Score (DTS) of 5.0 indicates low risk.
Preview
Print
Page Setup
Help
Exit

V. Reports

A. Overview

The software provides the following reports.

- Cover Page Report
- Summary Table Report
- Average Beat Report (Summary or Detailed)
- Trend Report
- Resting ECG Report
- Rhythm Strip Report (Summary or Detailed)

By default, the software prints all reports except the Trend Report. Customize report printing to include only the reports required.

B. Cover Page Report

The Cover Page Report provides a single page summary of the Stress test. This report consists of patient data, test-related data, test summary data and interpretation text.

Patient Data

The *Patient Data* area shows the patient's name, ID number, sex, age in years (calculated from the date of birth), medications, weight and height as drawn from the IQmanager® *Patient Data* screen.

Test-Related Data

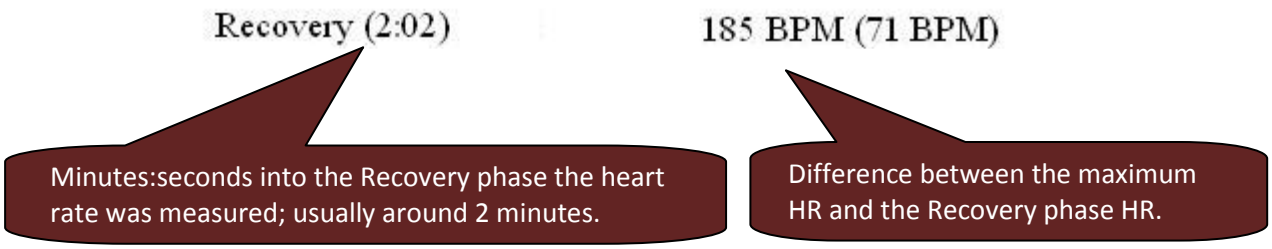
This data pertains to the Stress test and includes the name of the requesting physician, the name of the person performing the test, the name of the physician that supervised the test and the indication or reason for performing the test. This area also shows the test date and time the test was completed, the test type and the exercise protocol used.

Heart Rate Measurements

Heart rate measurements include the Pre-Exercise phase HR, the maximum HR during the Exercise or Recovery phases, the target HR, the percentage of the target HR and the Recovery phase HR.

The percentage target HR is the ratio of the maximum HR to the target HR for the patient.

The report shows the Recovery phase heart rate in the following format:


Recovery (2:02)
185 BPM (71 BPM)
Minutes:seconds into the Recovery phase the heart rate was measured; usually around 2 minutes.
Difference between the maximum HR and the Recovery phase HR.

The software displays the HR at two minutes into the Recovery phase even if it's longer than two minutes. If the Recovery phase is less than two minutes, the software shows the heart rate at the end of the Recovery phase. If there is no Recovery phase for the test, this display will indicate *Not Available.*

METS Measurements

The METS measurements area shows the maximum number of METS achieved based upon the exercise level, the target METS for the patient and the percent target METS. The percent target METS is the ratio of the maximum METS achieved to the target METS.

ST Level and Slope Measurements

These display areas show the following information.

- ECG lead on which the worst ST depression occurred
- Pre-Exercise phase ST level and slope for this lead
- Maximum ST level (depression) and slope
- Phase name and phase time (minutes:seconds) at which the maximum ST depression occurred
- Change in ST level and slope between the Pre-Exercise phase value and the maximum ST depression

Blood Pressure and Double Product

The measurements displayed here include the Pre-Exercise phase BP, the maximum BP and the double product (DP) for each of the BP measurements. The Pre-Exercise phase BP is the last BP reading entered prior to the start of the Exercise phase.

The DP is shown as the product of the systolic BP times the heart rate at the time of the BP reading divided by 100.

Ventricular Activity

The *Ventricular Activity* display area shows the maximum VE/min. that occurred during the test along with the phase name and phase time (minutes:seconds) into that phase.

Level of Effort

The *Level of Effort* consists of the total exercise time (minutes:seconds) and the Borg Scale entry entered at the end of the test.

Reason for Termination

This area shows the reason for terminating the test as entered before saving the report.

Interpretation

This portion of the report shows the interpretation text as entered by the physician.

C. Summary Table Report

The Summary Table Report shows:

- Phase and stage times
- Exercise level (speed, grade and METS)
- HR
- BP
- DP
- VE/min
- ST level for the three leads with the worst ST depression for each Pre-Exercise stage and each minute of the Exercise and Recovery phases.

D. Average Beat Report

The Average Beat Report shows the phase name and stage time, exercise level, HR, the averaged QRS complex for each lead and the ST level, slope and QRS amplitude for each lead. Each page of the report contains up to three average beats.

There are two formats of the Average Beat Report. The Summary Average Beat Report is a one-page report that shows the average beats for Pre-Exercise phase, peak Exercise phase and Recovery phase. This is the default report format.

The Detailed Average Beat Report is a multi-page report showing all average beats stored for the Stress test report.

Select which type of report to print in the configuration settings described in *Section II-E, Configuration Settings*.

E. Trend Report

The Trend Report is a single page printed version of the *Trend* screen. See *Section IV-G, Trends Screen* for a description of the trended data.

F. Resting ECG Report

The Resting ECG Report shows the interpretation, general measurements and twelve leads of ECG data. The software provides the following printing formats for the Resting ECG Report.

- 6x2 12-lead format (default)
- 12-lead plus 3-lead rhythm
- 12-lead simultaneous
- 12-lead plus 1-lead rhythm

G. Rhythm Strip Report

Each stored rhythm strip in the Stress report contains ten seconds of ECG and ST level and slope measurements for all leads. The format and amount of ECG shown on each page of the Rhythm Strip Report depends on the report page format that is selected.

The report page formats are three-lead, six-lead, twelve-lead, 6x2 twelve lead plus average beats and twelve-lead plus one rhythm lead (default). Except for the twelve-lead plus one rhythm lead format, the others may include the average beats depending upon the configuration settings. Specify the lead groups for the three-lead and six-lead page formats.

There are two report formats. The Summary Rhythm Strip Report is the default, typically consists of four or five printed pages with the following stored rhythm strips:

- All Pre-Exercise phase rhythm strips
- Peak Exercise phase rhythm strip
- Recovery phase rhythm strip

The Detailed Rhythm Strip Report prints all stored rhythm strips including continuous rhythm strips. This report may contain up to twenty or more printed pages depending upon the configuration settings for rhythm strip storage.

Real Time Rhythm Strip Printing

The software provides the following options for printing the rhythm strip from the real time display screen. The ECG leads used for rhythm strip printing are the same as the leads displayed on the real-time screen. No average beats will be printed.

- 10 seconds rhythm strip (default)
- 30 seconds rhythm strip
- Continuous rhythm strip

NOTE: For better performance, a fast laser printer is recommended. A slow printer will take more than 10 seconds to print a 10-second rhythm strip, which

result in the rhythm strips being printed out of real-time. However, all 10-second rhythm strips will be printed eventually from the printer queue. The 10-second rhythm strips will also be saved in the Stress test report for reviewing, editing and printing.

The page number for the rhythm strips will be printed as Page1, Page 2, ...

H. Resting ECG Report

The Resting ECG Report shows the interpretation, general measurements and twelve leads of ECG data. The software provides the following printing formats for the Resting ECG Report.

- 6x2 12-lead format (default)
- 12-lead plus 3-lead rhythm
- 12-lead simultaneous
- 12-lead plus 1-lead rhythm

VI. Operations at a Glance

The following is a quick start guide for creating a Stress test report for a new patient:

1. Select a patient or and click **New Patient** from the opening screen.

2. Complete the fields on the *Patient Data* screen as accurately as possible. The patient's name and ID are required to perform a test, and the program uses the patient's date of birth and sex for the test results.

3. Start a new exercise test by clicking **New Test** on the patient data screen.

4. Select the Stress test and enter relevant information. Click **OK**.

5. Prepare the patient and attach the electrodes. Refer to the Quick Reference User's Guide included with the IQstress kit for patient hook-up or refer to *Section III – B, Patient Preparation* for details.

6. Wait for the ECG tracings to stabilize. When the signal quality is good and the baselines are stable, click **Stage Up (F4)**. The phase display will indicate *Learning*. The software requires about 30 seconds to analyze and learn the ECG pattern.
   NOTE: If artifacts or noise occur in the ECG signal, see *Section XV-Appendix A, Troubleshooting IQstress®*.

7. When the program finishes learning the ECG, it automatically enters the Supine stage of the Pre-Exercise phase. Follow the instructions in the message prompt for each Pre-Exercise phase.

8. When ready to start the Exercise phase and the message prompt shows *Prepare for exercise. Click Stage Up (F4) to start*, have the patient stand on the treadmill's side panels so as to straddle the belt. Press **F4** to start the treadmill.

9. Instruct the patient to step onto the moving treadmill belt.

10. To terminate the Exercise phase, click **Recovery (F9)**. After the treadmill has come to a stop, have the patient move to the exam table and lie down.

11. Continue monitoring during the Recovery phase until the patient's cardiac condition returns to the Pre-Exercise condition.

12. End the Stress test by clicking **Exit (F12)**. Enter the reason for termination (required), the level of chest pain (required) and the Borg scale (optional).

13. Reports are automatically saved and can be viewed after clicking **Exit**.

VII. Function and Shortcut Key Summary

Shortcut	Function	Description
F1	Start/Stop Treadmill	• **Start Treadmill**: Starts the treadmill at the current setting. • **Stop Treadmill**: Stops the treadmill.
F2	Stage Down	Returns to the previous protocol stage. The software adjusts the treadmill speed and grade automatically.
F3	Stage Hold/ Stage Release	Places and releases a stage hold mode on the treadmill control logic. The button label alternates on each click. The treadmill remains at the current stage until one of the following buttons are clicked on: **Stage Release**, **Stage Down** or **Stage Up**.
F4	Stage Up	Advances the protocol to the next stage. The software automatically changes the treadmill speed and grade.
F5	Enter BP	Displays the *Enter BP* dialog box to enter a new BP reading.
F6	Save 12 Ld/ Print 12 Ld	Saves or prints and saves, as determined by the *Report Settings* in the *User Profile Settings*, the last ten seconds of the ECG in twelve-lead plus one rhythm strip lead format with the report.
F7	Print Scrn	Prints and saves a 10-second, 30-second or continuous rhythm strip. Printout format is determined by the *Report Settings* in the *User Profile Settings*. All printouts will include the last ten seconds of ECG and will be saved as part of the final report.
F8	Freeze/Unfreeze	Displays and closes the *Freeze Display*. The button label alternates on each click.
F9	Resting ECG or Recovery	Stops the treadmill and starts the Recovery phase. If there is a cool-down stage programmed for the Recovery phase, the speed and grade will change to the pre-programmed settings.
F10	Adjust ST	Displays the Adjust ST dialog that allows the user to adjust the isoelectric and J points for average beats.
F11	Settings	Displays the *IQstress Settings* dialog box in the Hookup phase.
F12	Exit	Ends the test and saves the report.
← (left arrow)	Slower	Reduces the treadmill speed by 0.1 MPH/KPH.
→ (right arrow)	Faster	Increases the treadmill speed by 0.1 MPH/KPH).
↓(down arrow)	Lower	Decreases the treadmill grade by 0.5%.
↑ (up arrow)	Higher	Increases the treadmill grade by 0.5%.
Alt + C		Displays the chest lead group (V1-V6) in the ECG tracing window and the average beat display.
Alt + L		Displays the limb lead group (I, II, III, aVR, aVL, aVF) in the ECG tracing window and the average beat display.

Shortcut	Function	Description
Alt + A		Displays all twelve leads in the ECG tracing window. Does not change the average beat display.
Alt + R		Rotates to the next lead group in the ECG tracing window. Does not change the average beat display.
Alt + E		Displays the expanded average beat display for the last selected lead.
Alt + S	Sweep Speed Selector	Rotates the sweep speed (12.5, 25 or 50 mm/s) in the ECG tracing window.
Alt + G	Gain Setting	Rotates to the gain (1/2x, 1x, 2x) in the ECG tracing window and the average beat display.

NOTE: There is an auto **Stage Hold** feature. When one of the following treadmill commands (keys) is pressed, the software automatically enters **Stage Hold** state:

- **Slower** (left arrow)
- **Faster** (right arrow)
- **Lower** (down arrow)
- **Higher** (up arrow)

VIII. Stress Output Module (SOM)

A. Configuration

The Stress Output Module (SOM) is an optional component of the Midmark stress test diagnostic software that provides digital and analog outputs to auxiliary equipment such as echocardiographs for stress echocardiography procedures, automatic blood pressure measurement devices and other auxiliary equipment.

IQstress® Stress Output Module

Each SOM comes with two sets of connection kits consisting of a BNC (male)-to-BNC (male) cable, a BNC (female)-to-RCA (male) adapter, and a RCA (female)-to-Mono ¼" Plug adapter. These adapters account for the most common types of connectors found on echocardiographs, automatic blood pressure devices and other auxiliary equipment.

BNC-to-BNC Cable

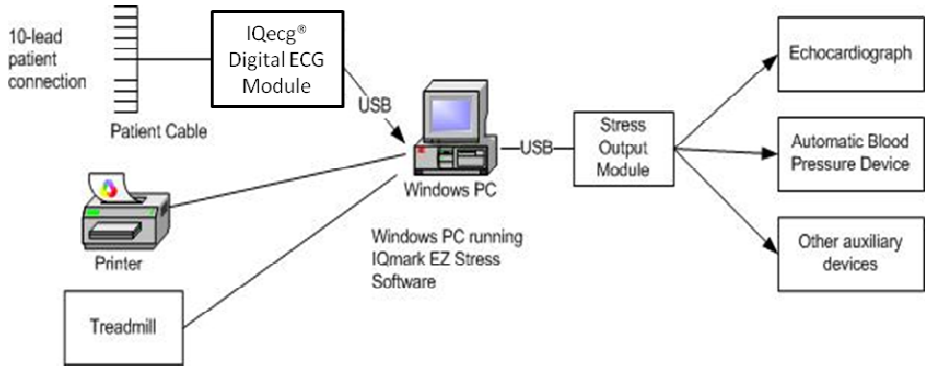
BNC-to-RCA Adapter

RCA-to-1/4" Mono Plug

NOTE: Some auxiliary equipment may require an additional upgrade or proprietary connection kit from the manufacturer. Please check the device manual to ensure the equipment is set up to connect to any standard exercise stress device.

Block Diagram

The diagram below illustrates the role of the SOM within the stress test setup:



The SOM interfaces via a Universal Serial Bus (USB) port to a Windows-based PC running the stress test software. The SOM provides two digital outputs for use as QRS triggers and four analog output signals.

Specifications

General Specifications	
Intended Use	• For use with Midmark stress test diagnostic software as a component of an exercise stress testing system. • The digital outputs provide real time QRS pulses for interfacing to ultrasound equipment for stress echo procedures, automatic blood pressure measurement devices or other equipment requiring a digital QRS synchronization pulse. • The analog outputs are intended for use with auxiliary monitoring devices that collect information produced by Midmark stress test diagnostic software. **CAUTION:** This device is not intended for use with defibrillators or other automatic resuscitation devices. **NOTE:** The ECG analog output signals are not intended for diagnostic ECG use; they are intended for reference or monitoring purposes only. **NOTE:** The SOM is intended for use with the USB version of Midmark digital ECG diagnostic modules and is disabled if using a serial port.
PC Interface	Full speed USB
Number of Digital Outputs	2
Number of Analog Outputs	4
Power Supply	USB powered
Current Requirements	< 50 ma

Package Dimensions (H x W x D)	1.5” x 4.5” x 4.5”

Digital Output Specifications	
Signal Range	0 – 5V
QRS Pulse Width Setting Range	40 – 150 ms (+/- 10 ms), software controlled
QRS Pulse Delay Setting Range	0 – 100 ms (+/- 10 ms), software controlled
Phase Delay Relative To Input	< 40 ms
Short Circuit Protected	Yes
Connector Type	BNC

Analog Output Specifications	
Signal Range	+/- 5V
Output Signals	ECG Leads: I, II, V1, V2, V3, V4, V5, V6 Analog Voltages: heart rate, treadmill speed, treadmill grade, ergometer watts, ergometer RPM.
ECG Lead Sensitivity	1 volt/mv
Heart Rate Output Sensitivity	60 BPM/volt
Treadmill Speed Output Sensitivity	3 MPH/volt
Treadmill Grade Output Sensitivity	5% grade/volt
Analog Amplitude Accuracy	+/- 5%
ECG Delay Relative to Input	< 40 ms
Short Circuit Protected	Yes
Connector Type	BNC

B. Setup

Once the IQmanager® or IQstress® software has installed successfully, connect the Stress Output Module (SOM) to a USB port.

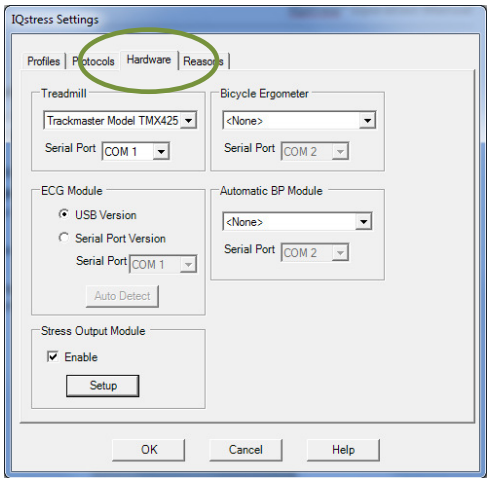
C. Operation

Hardware Configuration Settings

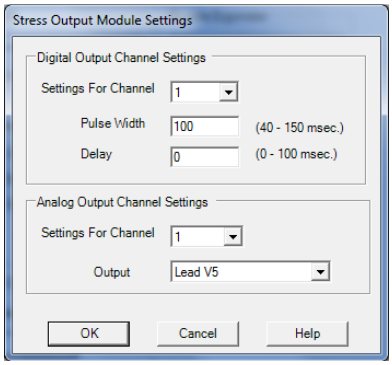
Midmark stress test diagnostic software provides various settings that allow the user to configure the digital and analog outputs of the SOM.

1. The SOM must be configured prior to starting a stress test. To begin, click **Settings**, which is available on the *Review and Edit* screen or the *Pre-Test Settings* dialog box of the Midmark stress test diagnostic software.

2. Click the *Hardware* tab.



3. Checking the *Enable* box enables the **Setup** button. Click **Setup** to display the SOM *Settings* dialog box.



4. The SOM *Settings* dialog box consists of two groups of controls: *Digital Output Channel Settings* allows the user to set the two digital output channels; *Analog*

Output Channel Settings allows the user to setup the four analog output channels.

a) Digital output channel: Select the channel in the *Settings for Channel* list in the *Digital Output Channel Settings* control group; enter the pulse width for the channel in the *Pulse Width* edit box, then enter the pulse delay in the *Delay* edit box.
b) Analog output channel: Select the channel from the *Settings for Channel* list in the *Analog Output Channel Settings* control group; select the desired signal from the *Output* combo box and repeat for each channel.

NOTE: The pulse width setting determines the width of the digital pulse output for each QRS pulse detected. The default setting is 100 milliseconds (ms). The delay setting determines how long the software delays the pulse relative to when the QRS complex is detected. The default setting is 0 ms.

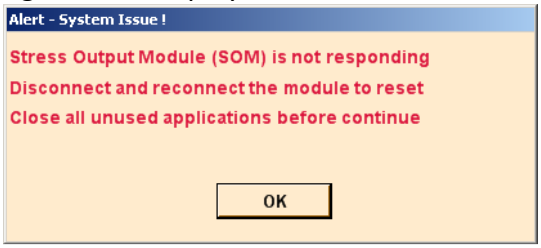
NOTE: Each analog output channel may be individually configured to output different signals.

Stress Output Module Dialog Controls			
	Control	**Control Type**	**Description**
Digital Output Channel Settings	Settings For Channel	Combo Box	Selects the digital channel to which the settings will be applied; the choices are 1 or 2.
	Pulse Width	Edit Box	Displays the pulse width setting. The allowable range is 40 – 150 ms. The default setting is 100 ms.
	Delay	Edit Box	Displays the pulse delay setting. The range is 0 – 100 ms. The default setting is 0 ms.
Analog Output Channel Settings	Settings For Channel	Combo Box	Selects the analog output channel to which the settings will be applied. The choices are 1, 2, 3 and 4.
	Output	Combo Box	Selects the output signal. The choices are: • Lead I • Lead II • Lead V1 • Lead V2 • Lead V3 • Lead V4 • Lead V5 (default for all analog output channels) • Lead V5 • Lead V6 • Heart Rate • Treadmill Speed • Treadmill Grade • Ergometer watts • Ergometer RPM

D. Stress Test Operation

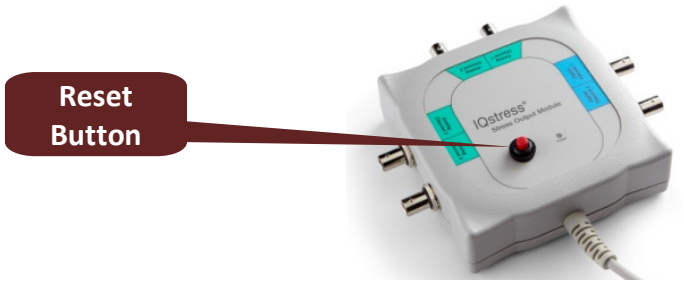
The analog outputs of the SOM become active when starting a new stress test. The digital outputs become active approximately ten seconds after pressing the Stage Up (F4) button in the Hookup phase of the test. All outputs will remain active until the stress test is terminated and the Midmark stress test diagnostic software is exited.

If the computer performance is slow and causes the SOM to be out of synchronization, the following alert message will be displayed:


Alert - System Issue !
Stress Output Module (SOM) is not responding
Disconnect and reconnect the module to reset
Close all unused applications before continue
OK

To re-synchronize the computer and the SOM, take one of two actions:

A. Use the **Reset Button** on the SOM:
   1. Click **OK** in the alert message box.
   2. Push the red **Reset** button firmly once.
   3. The SOM will be activated within seconds.



SOM with Reset button

B. If the SOM does not have a reset button:
   1. Click **OK** in the alert message box.
   2. Disconnect the SOM's USB cable from the computer.
   3. Wait for a couple of seconds, then, reconnect the USB cable to the computer.
   4. The SOM will be activated within seconds.

NOTE: Midmark software will continue to perform (e.g. displaying live ECG and vitals, saving and printing rhythm strips, controlling the treadmill) even when the SOM appears not to be responding. However, to prevent this, please call Technical Service and we can help improve the performance of your computer.

E. Troubleshooting the SOM

Troubleshooting Guide	
Error Message or Problem	**Solution or Recommendation**
An error message appears: **ERROR: THE STRESS OUTPUT MODULE IS NOT CONNECTED…**	Exit the software, connect the SOM to a USB port of the computer and run the software again.
No output signals detected by the auxiliary equipment.	• Check the connections between the SOM and the auxiliary equipment. • Verify the SOM is enabled on the *Hardware Settings* tab of the *Stress Settings* dialog box. • Verify the channel settings in the SOM are correct for the auxiliary equipment.
The green LED on the SOM does not turn on when a Stress test is started.	The LED should turn on in the Hookup phase when starting a new Stress Test. • Make sure that the SOM is connected to a USB port of the PC. • Verify that the SOM is enabled on the *Hardware Settings* tab of the *Stress Settings* dialog box.
The green LED on the SOM does not turn on when the module is initially plugged into a USB port.	The device drivers have not been properly installed. • Reinstall the device drivers as described in *Section VI-A*.
The green LED on the SOM turns on but does not blink.	The green LED will start to blink once the software detects QRS complexes (normally about ten seconds after pressing the Stage Up (F4) button in the Hookup phase to start learning). • If the LED does not start blinking about ten seconds after learning begins, verify that valid ECG signals are displayed on the screen. • If there is a lead disconnected, or if the heart rate display indicates "---", correct the problem and exit the software. • Restart the software and verify that the hookup is good. • Press **Stage Up (F4)** to restart learning.

IX. SunTech® Tango® Automatic BP Device with IQstress®

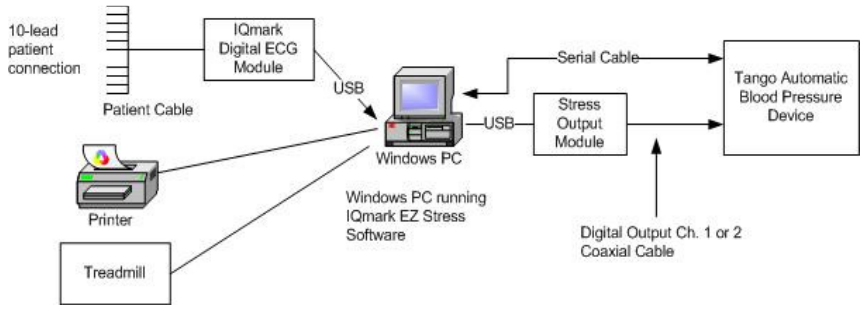
> **NOTE:** In order to use the Tango® device with IQstress® a Stress Output Module (SOM) is needed. See Section VIII, Stress Output Module (SOM) for instructions on how to connect and configure the Stress Output Module.

Prior to using the Tango® BP device, connect it to the computer and configure the software; if your Tango® BP device has already been connected and configured.

A. Configuring IQstress® for Use with the SunTech® Tango® Device

The following block diagram shows the Tango® Automatic Blood Pressure Device connected to the IQstress® system:

> **NOTE:** The SOM requires the USB version of the ECG module. The digital QRS synchronization pulse from the SOM will not be available if using the serial port version of the ECG module.



The SOM provides a digital QRS synchronization pulse to the Tango® device. The software controls the Tango® device and receives BP measurements from it via the serial cable.

The required cables are available from SunTech® as follows:

Cable	SunTech Part Number	Description
Serial RS-232	91-0013-00	9-pin female to 9-pin female
Coaxial	91-0011-00	BNC to BNC

1. Connect the SOM to one of the USB ports on the computer.

2. Connect one end of the coaxial cable to the channel 1 or 2 digital output BNC connector of the SOM. Connect the other end to the BNC connector on the Tango® device.
3. Connect one end of the serial cable to one of the COM ports on the computer and the other end to the serial RS-232 connector on the rear of the Tango® device.

NOTE: If there are no available COM ports on the computer, then it will be necessary to use a USB-to-serial port adapter for the Tango® device. Install the USB adapter according to the manufacturer's instruction then connect the USB adapter to the computer and the Tango® device to the serial port connector of the USB adapter.

Configuring the Tango® Device

NOTE: The Tango® device may be a newer model than described below. Follow the installation and setup instructions that come with the Tango® device.

The following instructions describe how to configure the Tango® device:

1. Turn on the device using the switch at the rear-top-left corner of the device.
2. Once the operating screen is displayed, click the *MENU*/SELECT button. Use the UP or DOWN buttons to select **Utilities** and click the menu button.
3. Use the arrow buttons to select **Device** and click the MENU/*SELECT* button to edit.
4. Choose **SUNTECH** using the arrow buttons and click the select button to confirm the choice.
5. Select **ECG trigger** and click the select button to edit. Choose **DIGITAL**↑ and click the select button to confirm the choice.
6. Select **Exit** twice to return to the operating screen.

Configuring the IQstress® Software

To configure the software to communicate with the Tango® device:

1. Display the *IQstress Settings* dialog box and click on the *Hardware* tab.
2. Select *SunTech Tango* from the drop-down list in the *Automatic BP Module* control group.
3. Select the COM port that the Tango® device is connected to from the *Serial Port* drop-down list.

The software may be configured to control the Tango® device in the following ways.

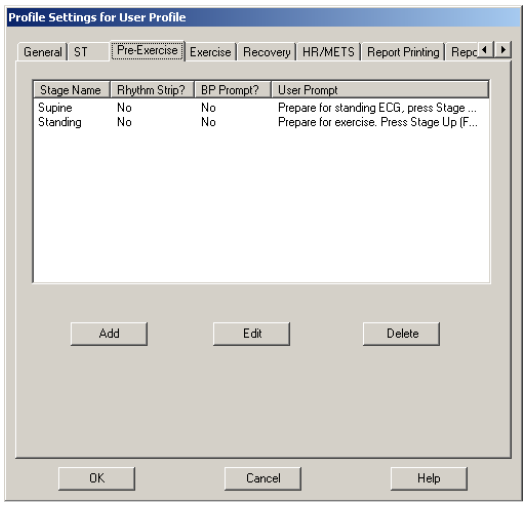
- Automatic measurements initiated by the software at each stage of the Pre-Exercise phase.
- Automatic measurements at timed intervals of the Exercise phase.

- Automatic measurements at timed intervals of the Recovery phase.

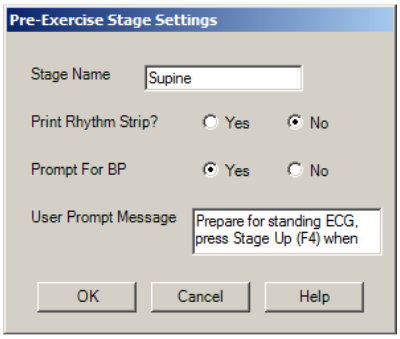
Each user profile may be programmed for different Tango® configurations. Select the *Profiles* tab of the *IQstress Settings* and double-click on the profile in the list to configure each phase of the exercise test.

Automatic BP during the Pre-Exercise Phase

1. Click on the *Pre-Exercise* tab of the *Profile Settings* dialog box to display the *Pre-Exercise Settings*.



2. Select a Pre-Exercise stage from the list and click **Edit** to display the *Pre-Exercise Stage Settings* dialog box.

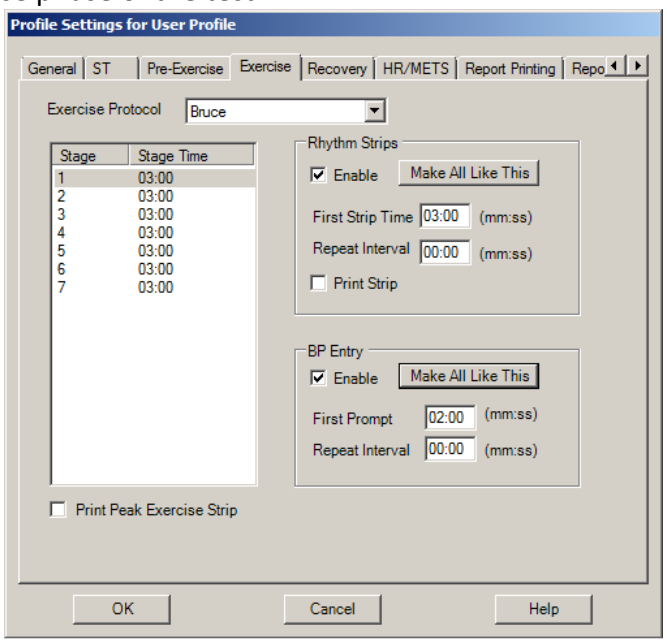


3. Select *Yes* next to *Prompt For BP* program the software to initiate an automatic BP reading for the Pre-Exercise stage; otherwise select *No.*

4. Repeat the above procedure for each Pre-Exercise stage.

Automatic BP during Exercise

1. Click on the *Exercise* tab of the *Profile Settings* dialog box to display the settings for the Exercise phase of the test.



2. Select a stage from the list and check the *Enable* box in the *BP Entry* control group if timed BP measurements are wanted during the stage.

3. Enter the start time of the first measurement in the *First Prompt* edit box.

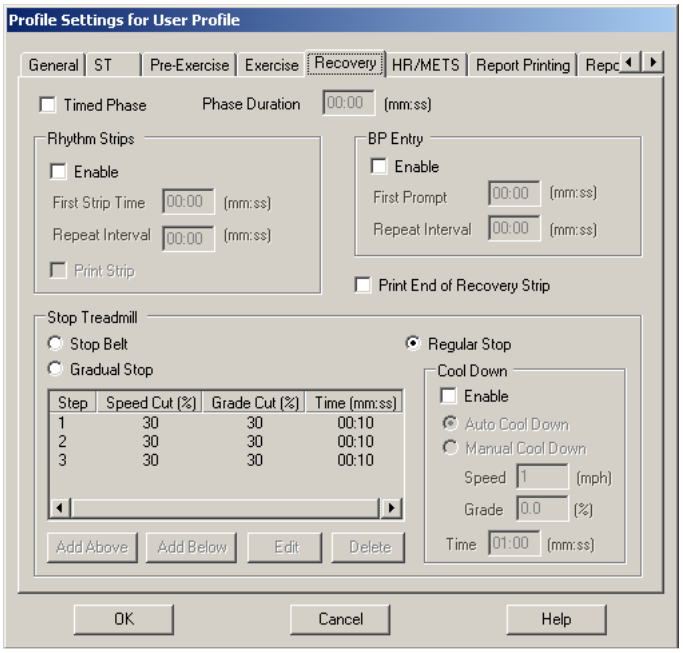
4. If more than one timed BP measurement is wanted during the stage, enter the measurement interval in the *Repeat Interval* edit box. If only one timed BP measurement is wanted during the stage, enter *00:00* in the *Repeat Interval* edit box.

5. Click **Make All Like This** if you want all stages in the Exercise phase to be the same as the displayed settings.

The times specified in this dialog will be the times at which the automatic BP sample is started. Bear in mind when setting the times, the Tango® device requires between 40 and 60 seconds to complete the measurement.

Automatic BP during Recovery

1. Click on the *Recovery* tab of the *Profile Settings* dialog box to display the *Recovery Settings*.



2. Check the *Enable* box in the *BP Entry* control group if timed BP measurements are wanted during the Recovery phase.

3. Enter the start time of the first measurement in the *First Prompt* edit box.

4. If more than one timed BP measurement is wanted during the Recovery phase then enter the measurement interval in the *Repeat Interval* edit box. If only one BP measurement is wanted during the Recovery phase, then enter *00:00* in the *Repeat Interval* edit box.

B. Using the SunTech® Tango® Device with IQstress®

The software will automatically display BP readings acquired from the SunTech® Tango® device on the screen and include these readings in the test report. There is no need to manually enter BP readings into the software.

In the Pre-Exercise phase, the software will initiate an automatic BP reading by clicking on **Stage Up (F4)**; the acquired BP measurement will be stored for the Pre-Exercise stage that has just started.

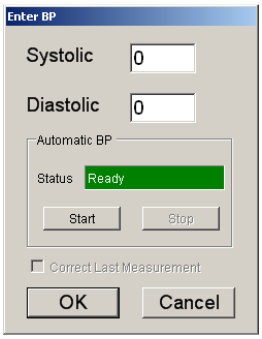
During the Exercise and Recovery phases, the software will initiate automatic BP measurements at the times that are programmed for the current phase and stage.

During the pre-programmed automatic measurement, **Enter BP** on the *Exercise Test* screen turns yellow then returns to green upon completion of the measurement; the software displays the new BP reading in the blood pressure display area at the top of the screen. If **Enter BP (F5)** is red, click on it to display the *Enter BP* dialog box for more details about the error. **Enter BP (F5)** is color coded as follows:

Enter BP Button Color	Meaning
Green	The Tango® BP device is idle.
Yellow	The Tango® BP device is performing a measurement.
Red	The BP measurement timed out because a measurement took longer than 90 seconds or some other error occurred.

Manually Starting a BP Measurement from IQstress®

Whenever the Tango® device is idle, manually start a BP sample by pressing **Enter BP (F5)**. The software will immediately start a BP sample and display the following dialog box:



The *Status* display area will indicate *Busy* and turn yellow. When the Tango® device completes the measurement, the software automatically closes the dialog and displays the new BP reading at the top of the display.

When the Tango® device is busy, stop the reading by clicking **Stop**. When the Tango® device stops, start a reading by clicking **Start**.

Status Conditions of the Enter BP Dialog Box			
Status Text	**Background Color**	**Foreground Color**	**Description**
Ready	Green	White	Automatic BP module is connected and ready.
Busy	Yellow	Black	Automatic BP module is measuring BP.
COM Error	Red	White	Software could not open the serial port specified in the *Hardware Settings*.
Disconnected	Red	White	The automatic BP module is not connected or turned off.

C. Troubleshooting the Tango® BP Device

The following table lists recommended solutions to some problems may be encountered. The SunTech® Tango®Operator's Manual provides additional troubleshooting tips.

SunTech Tango® BP Troubleshooting Guide	
Error Message or Problem	**Possible Solution or Recommendation**
Check ECG Message appears on the Tango® display screen.	The Tango® device is not receiving any QRS trigger pulses from the software via the SOM. • Verify that the coaxial cable between the SOM and the device is connected at both ends. • Verify that the green LED on the SOM is blinking. If the ECG signal quality is good and the software is displaying a valid heart rate value and if the green LED on the SOM is not blinking, see *Section VIII-E, Troubleshooting the SOM*. **NOTE:** If the initiated a BP reading from the device's front panel controls while the software is in the Hookup phase or is still in the process of learning the ECG signal, then the software has not started to send QRS pulses to the device yet. Make sure that the software has completed the learning process before attempting to start a BP reading.
COM Error Message appears in the *Enter BP* dialog.	The COM port for the Tango® device is not configured correctly. • Terminate the test, exit the *Exercise Test* screen, display the *IQstress Settings* dialog box and open the *Hardware* tab. Verify that the *Automatic BP Module Serial Port* drop-down list displays the correct COM port setting. • To display a list of COM ports available on the computer, display **Windows Device Manager**, expand the *Ports (COM & LPT)* list by clicking on the *+* symbol.
Disconnected Message appears in the *Enter BP* dialog.	• Verify that the serial cable is connected to both the device and the computer. • Verify that the correct serial port is selected in the *Automatic BP Module Serial Port* drop-down list of the *Hardware Settings* tab of the *IQstress Settings* dialog box. • Verify that the device is plugged in and is powered on. • Examine the Tango® display to see if there are any error messages displayed. Refer to the device's operations manual for explanation of the Tango® error messages.
The Tango® device does not start a BP sample during the Stress test.	• Verify that the software is properly configured for operation with the Tango® device. See *Section IX-B, Using the SunTech® Tango® Device with IQstress®*. • Verify that the Tango® device is properly configured for use with the software. See *Section IX-B, Using the SunTech® Tango® Device with IQstress®*.

SunTech Tango® BP Troubleshooting Guide	
Error Message or Problem	**Possible Solution or Recommendation**
ECG signal quality problems such as a low amplitude, wandering baseline, noisy signal, etc.	To have good ECG signal quality, the patient must be properly prepared, the lead placements be correct, the electrodes and lead wires be firmly secure. Follow the instructions in *Section III-B, Patient Preparation* for best performance. • Verify the electrodes are fresh, moist, and sticky, not dry or hard; check the electrode expiration date. • Verify that the patient lead wires and cables are not damaged or worn out. • Inspect connections between the electrodes, clips, lead wires, lead cable and the ECG module. • The exam room should not be too cold; the patient may shiver, causing a noisy signal. • If any of I, II, III, aVR, aVL and aVF on the screen are noisy or flat-lined, always check the *limb lead* electrodes for proper contact in this order: RL, LL, RA and LA. If a precordial lead is noisy or flat-lined, check the limb lead electrodes first, and then check the corresponding chest lead electrode for proper contact. Once identified, discard and replace the used electrode. Prepare the problem site again or try a new electrode site in close proximity to the original site. Note any site variance on test report. • If after the above steps, noise or artifact still occurs in the ECG, try the filter settings on the ECG screen. Turn the AC filter ON if 50/60Hz noise is detected. Verify that the Muscle filter ON. Verify that the Drift filter is ON if the ECG baseline is drifting. While these digital filters can improve signal quality, they cannot correct hookup problems. **NOTE:** As with any ECG measuring device, turning on the Muscle filter may alter measurements, which in turn may affect the test results. • Click **INST** to reset the baselines, or reset the ECG module. • Verify patient or examination room is not susceptible to energy interference such as electromagnetic fields from high power equipment like X-ray machines, power generators, power compressors, etc.

X. Maintenance and Storage

Cleaning

CAUTION

Do not use aromatic hydrocarbons, rubbing alcohol, or chlorinated solvents for cleaning the ECG module. Do not use alcohol or acetone on lead wires or cables as they can stiffen and crack the insulating plastic.

Clean the outside of the ECG module with a mild solution of detergent and water using a soft cloth. Avoid using excessive amounts of solution, which may infiltrate the connectors, battery compartments or the ECG module. If necessary, use a mild sterilizing detergent with low alcohol content that is generally used in hospitals. **Verify that all equipment, including accessories, is completely dry before using.**

Preventative Inspection

A preventative inspection should be done prior to each use of the ECG module. This is done to verify that there is no visible damage to the device that may cause it to malfunction.

Visual inspection should include the module and all cables for signs of damage and deterioration, including but not limited to, cracks, cuts, discoloration or oxidation. If a cable or other accessory exhibits any of these symptoms, replace it immediately prior to using the ECG module.

Storage

To prevent damage to the ECG module due to battery leakage or oxidation, remove all batteries if the ECG module is not to be used for a long period of time. Avoid extreme humidity and heat during storage.

NOTE: The USB version of the ECG module does not use batteries.

CAUTION: Electronic devices can be damaged by exposure to liquids. Do not use or store the IQecg® or any other components of the IQstress® system near any type of liquids.

Radio and Television Interference

This equipment generates and uses radio-frequency energy. If not installed and used properly in strict accordance with the manufacturer's instructions, it may cause interference to radio and television reception.

This equipment has been tested and proved to be in compliance with the standards for medical devices and in accordance with the IEC 601-1 rules, which are designed to provide reasonable protection against such interference in a medical or hospital environment.

XI. Customer Support and Warranty Information

For help diagnosing problems by phone with this product, contact Midmark Technical Service at (800) 624-8950, option 2, between 6:00 AM to 4:00 PM, Pacific Standard Time.

To contact Midmark Technical Service via email: techsupport@midmark.com

Self-help knowledge base and live can be accessed at: kb.midmark.com

Warranty

Midmark warrants IQecg® module (associated with the IQstress® System), to be free from manufacturing and material defects for 12 months from the date of purchase. Accessories for IQstress® are warranted for 90 days. The treadmill and computer, if applicable, are covered by the manufacturers' warranty. Any misuse or abuse of a Midmark product voids all applicable warranties.

Please refer to midmark.com for the full and current Warranty Terms and Conditions.

Return Materials Authorization

To return any product for repair, a Return Materials Authorization (RMA) number must be obtained from Midmark Technical Service. This RMA number should be referenced on the package(s) containing the items to be returned and in any correspondence regarding the return.

Shipping

Before shipping any unit to Midmark, be certain that an RMA number has been issued and that all guidelines regarding this authorization are followed. We highly recommend following all guidelines for the shipment of medical products set forth by the shipping company you choose to use. If a question should arise regarding the appropriate method of shipment, please feel free to ask when calling for your RMA number. It is ultimately the responsibility of the customer when shipping a product to ensure that all packages and their contents get to Midmark safely. Midmark will not assume responsibility for damage due to improper packaging, shipment or product use. Such actions will void all applicable warranties

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XII. Contact Information

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XIII. IQecg® Service Manual

Introduction

The Midmark IQecg® is a computer-based diagnostic instrument that converts any Windows-based computer to a 12-lead electrocardiograph with interpretative and data storage capabilities. A complete IQecg® system consists of the ECG data acquisition module, the computer system, which includes the monitor and the printer, the Microsoft Windows operating systems (Windows® 8, 7, or IQmanager® software program.

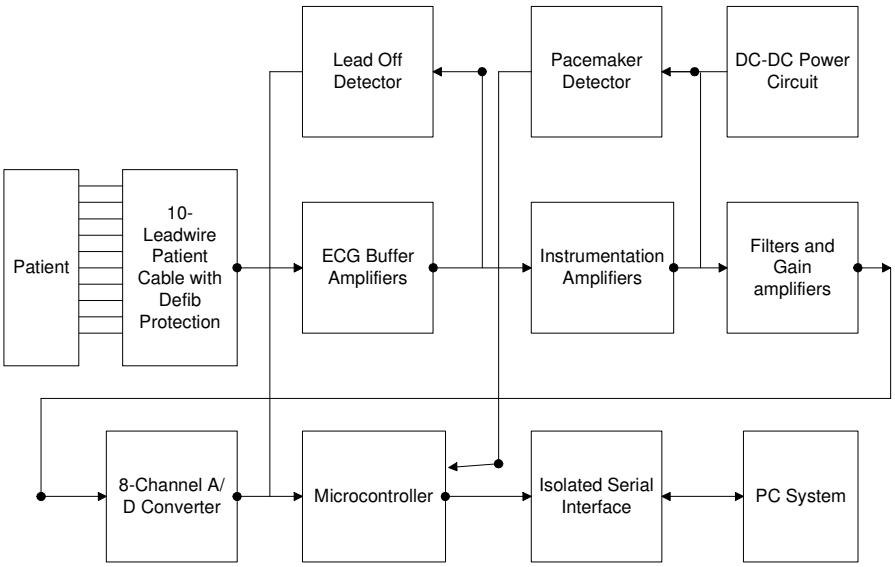
This manual is provided to assistance primarily with service of the IQecg® module. For information regarding the operation of the IQecg® module, refer to the *IQecg® Operation Manual*. For information about the service and operation of the computer system, please consult your computer's documentation.

Theory of Operation

The IQecg® module is an improved version of previous hardware modules.

Some new features for the IQecg® module include:

- Built-in defibrillation protection circuit
- Hardware lead-off detection circuit
- Hardware pacemaker detection circuit
- Analog bandwidth from 0.05Hz to 150 Hz
- Digital sample rate of 500 Hz
- USB computer interface (model-specific)
- RS-232/COM port interface (model-specific)
- Pocket computer compatible interface (model-specific)



System Block Diagram

10-Leadwire Patient Cable

The ECG module uses the special Midmark 10-Leadwire patient cable for its 12-lead ECG data acquisition. The patient cable has 10 conductor shielded lead wires. There is a 1Kohm (±10%) resistor embedded inside each lead wire. Together with the voltage clamping circuit built into the ECG front end, the ECG module provides the built-in defibrillation protection capability required by AAMI EC-11 and IEC-60601.

ECG Buffer Amplifiers

The patient ECG signals are first fed to the 8 ECG buffer amplifiers. These buffer amplifiers provide high input resistance for the patient interface with low output resistance to the instrumentation amplifiers.

Instrumentation Amplifiers

There are eight differential instrumentation amplifiers used in the ECG module, providing eight output signals from CH0 to CH7. Each differential amplifier has two inputs, one positive and one negative.

The following table lists the positive and negative inputs for each channel.

Channel Number	Positive Input	Negative Input
CH0	LA	RA
CH1	LL	RA
CH2	V6	Wilson Center
CH3	V5	Wilson Center
CH4	V4	Wilson Center
CH5	V3	Wilson Center
CH6	V2	Wilson Center
CH7	V1	Wilson Center

The Wilson Center is a reference point combined with the three limb leads.
The purpose of the instrumentation amplifier is to provide a high Common Mode Rejection Ration (CMRR), rejecting common mode signals such as 60 Hz line noise.

Filters and Gain Amplifiers

After the instrumentation amplifiers, the 8-channel ECG signals are passed into two stages of filters. The first stage consists of eight first-order high-pass filters with a cutoff frequency of 0.048Hz. The second stage consists of eight low-pass filters with a cutoff frequency of 159Hz. The ECG signals are also amplified to match the AD converter input dynamic range of 0-2.5V.

There are eight test points provided on the PCB board. The test points are labeled as CH0, CH1, CH2, CH3, CH4, CH5, CH6 and CH7. The signals measured on these test points are amplified with a gain of 125 and DC offset to 1.25Volt.

Analog to Digital Conversion

The AD converter used is ADC12138 from National Semiconductor. The AD converter is 12-bit plus sign serial I/O A/D converter with MUX and Sample/Hold. The amplified and filtered 8-channel ECG signals are passed to the 8-channel inputs of the AD converter. The sampling rate for each channel is 500Hz. The digitized ECG data are sent to the microcontroller through the serial interface.

Microcontroller

The microcontroller is a PIC16LC67 chip from Microchip Technology. This chip has 8Kx14 OTP, 33 I/O lines and built-in serial interfaces for A/D converter and RS232. The microcontroller receives the digitized ECG data from the AD converter and encodes the data with packets and sends out to the computer through serial interface circuitry. The setting for the RS232 is 8 bit data, 1 bit stop, no parity, and 115,000-baud rate and is usually handled automatically. Settings for the USB version are automatic and are not user selectable.

Isolated Serial Interfaces

To provide the maximum safety for the patient, the ECG module and the computer are isolated with an optical coupler and/or isolated DC to DC converters. The serial signal sent out by the PIC microcontroller is coupled optically to the computer either through the RS232 or USB interface. There is no electrical connection between the patient and the computer. The isolation circuit can withstand up to 1000Volts.

Lead-Off Detector

The ECG module has a built-in lead-off detection circuit. The lead-off circuit senses the lead-off condition and reports to the PIC microcontroller. The PIC microcontroller sends out the lead off condition to the computer through the serial interface.

Pacemaker Detector

The pacemaker detection circuit in the ECG module ensures the device's capability of printing the ECG signal in the presence of pacemaker pulses with amplitudes between 2 and 250 mV, duration between 0.1 and 2.0 ms recommended by AAMI EC-11.

DC-DC Power Converter

The IQecg® module (45 Series / RS232) uses two AA batteries to supply its power.

The IQecg® module (46 Series / USB) does not require the use of batteries. The USB port of the host computer provides the operating power. A step up DC-DC converter is used to provide a 4.5Volt power source. Two 3.3Volt regulators are used to provide two 3.3Volts power source for the analog circuits and digital circuit for the device. There is also a negative voltage converter used to generate a 3.3Volt power source for the analog circuit. A Linear Technology 1.25Volt micropower shunt reference regulator provides precision 1.25Volt reference voltage. The IQecg® module (46 Series / USB)

power is switched on or off by the ECG program through the USB port. Isolation is provided for signals entering the ECG module and can withstand up to 1000Volts.

XIV. System Maintenance and Obtaining Service

The IQecg® module is a portable device and requires little maintenance. To ensure the best performance of the device, the following procedures are recommended:

- Keep the patient cable clean.
- Do not unplug the patient cable from the ECG hardware.
- When the device LED turns red or the computer screen displays low battery, (45 Series / RS232 version only) replace the batteries inside the device *before* continuing.

The IQmark® and IQecg® Digital ECG acquisition modules contain no user adjustable or serviceable parts and are designed to operate without adjustment for the lifetime of the product.

However, electronic equipment can be subject to wear and damage that can cause malfunctions. A certification policy is the responsibility of the end user and is subject to the end users' business practices which may require it. Certification provides peace of mind that the device continues to work within factory specifications. Certifications can be purchased directly from Midmark.

Please contact Technical Service at 800-624-8950, option 2, with questions or to make arrangements for the certification of an IQmark® Digital ECG or IQecg® Digital ECG device.

> **NOTE:** Return authorization is required prior to the return of the device. Midmark Technical Service will issue a Return Materials Authorization (RMA) number prior to shipment.

XV. Appendices / References

A. Appendix A - Troubleshooting IQstress®

This *Troubleshooting Guide* provides a list of solutions or recommendations to situations that may be encountered with IQstress®. Before calling Midmark Technical Service, please refer to the following table for help. Error messages may be displayed at the center or at the bottom-right corner of the screen.

> **NOTE:** For errors that occur during the management of Stress report files, refer to *Troubleshooting Section* in the *IQmanager® Operation Manual*.

IQstress® Troubleshooting Guide	
Error Message or Problem	**Solution or Recommendation**
Alert - System Issue! Stress Output Module is not responding. Message appears during a Stress test.	The software detects a computer performance issue that causes the SOM to stop responding. • Make sure all unused applications are closed. • To reset the SOM, disconnect and reconnect the SOM from the computer.
Color resolution must be 16 bits/pixel or greater Message appears when starting a new Stress test.	The computer does not meet the minimum requirements for display color resolution. Change the display color resolution as follows: 1. Right click on the Windows desktop. 2. Select *Properties*. 3. Click on the *Settings* tab of the *Display Properties* dialog box. 4. Select a higher color resolution from the *Colors* list. 5. Click **OK**. 6. Run the software again.

IQstress® Troubleshooting Guide	
Error Message or Problem	**Solution or Recommendation**
COM Error Treadmill status display	The software could not open the COM port specified for the treadmill. • The COM port is in use by another device. Select a different COM port for the treadmill, if one is available. If no more serial ports are available, uninstall the device using the COM port. • The specified COM port does not exist on the computer. Display the *Hardware* tab of the *Settings* dialog box and select the correct COM port. If the available COM ports are not known, use the Windows Device Manager: open **My Computer**, select *Properties* from the pop-up menu, slick on the *Hardware* tab, then click **Device Manager**. Click the **+** (plus) next to *Ports (COM & LPT*) in the device list to view the list of available COM ports.
CPU clock speed must be greater than 600M Hz. Message appears when starting a new Stress test.	The computer does not meet the minimum speed requirements for the software. • Install the software on a faster computer.
Disconnected Treadmill status display	The treadmill is not connected to the computer, it is powered down or its mechanical emergency stop button (ESB) is engaged. • Verify the connection between the treadmill and the computer; check that the serial port selection is correct in the *Hardware* tab of the *IQstress Settings* dialog box. • Check that the treadmill is plugged in. • Check the treadmill's power switch is on. • Check that the ESB is released. To release the ESB, turn the red knob. 🔔 **NOTE** to Trackmaster® TMX425 and TMX428 users: The Trackmaster® treadmill has a built in safety feature that prevents the computer from controlling treadmill when the mechanical emergency stop button (ESB) is pressed.

IQstress® Troubleshooting Guide	
Error Message or Problem	**Solution or Recommendation**
ECG Module Low Battery Message appears in the message prompt.	Replace the batteries in the ECG module.
ECG Module Not Responding Message appears in the message prompt.	This message appears in the prompt display of the Hookup or *Exercise Test* screens for both the USB and serial port version of the ECG module. • See above if using the USB version of the ECG module. • If using the serial port version of the ECG module, the *Auto Detect* dialog box will appear; connect the ECG module to a COM port then click **Start** on the *Auto Detect* dialog box to have the Auto Detect software scan the COM ports and determine which port the ECG module is connected to. The dialog will close if the software successfully detects the ECG module. If unsuccessful, the *Auto Detect* dialog will display further instructions.
ECG module not responding. Connect the ECG module to the USB port. Click OK to try again. Message appears when starting a new Stress test or during the Stress test.	This message appears only if using the USB version of the ECG module. • Connect the ECG module to a USB port on the computer and click **OK**. • Click **Cancel** then click **Exit (F12)** to exit the software if you are unable to resolve the problem.

IQstress® Troubleshooting Guide	
Error Message or Problem	**Solution or Recommendation**
ECG Module Serial Port Error Message appears in the message prompt.	This message only appears if you are using the serial port version of the ECG module. The software could not open the COM port specified for the ECG because: • The COM port is in use by another device. • The specified COM port does not exist on the computer. • The *Auto Detect* dialog box will appear; connect the ECG module to a COM port then click **Start** on the *Auto Detect* dialog box to have the Auto Detect software scan the COM ports and determine which port the ECG module is connected to. The dialog will close if the software successfully detects the ECG module. If unsuccessful, the *Auto Detect* dialog will display further instructions.
Error: PC ECG I device connected Message appears in the message prompt.	The software detected that a Brentwood PC ECG I module is connected to the specified serial port; this message appears only if using the serial port version of the ECG module. • The software cannot operate with a Brentwood PC ECG I module. Acquire a Midmark IQecg® module to use the software. Please contact Midmark Technical Service.
Error: Spirometry device connected Message appears in the message prompt.	A Spirometer device is connected to the serial port assigned to the ECG module; this message appears only if using the serial port version of the ECG module. • Disconnect the Spirometer and connect the ECG module to the serial port, or change the serial port assigned to the ECG module in the *Hardware* tab of the *Settings* dialog box.
Error: Unknown device connected Message appears in the message prompt.	The software was able to read data from the COM port but it could not identify the connected device. • Disconnect the device connected to the serial port and connect the serial port version of the ECG module.

IQstress® Troubleshooting Guide	
Error Message or Problem	**Solution or Recommendation**
Exercise protocol complete. Press Recovery (F9) to begin recovery Message appears in the message prompt.	This is not an error. This message indicates that the Exercise phase has ended. Continue to allow the patient to exercise. Click **Recovery (F9)** to end the Exercise phase and begin Recovery.
IQstress® Security Key Not Found Message appears when starting a new Stress test.	The software cannot find the security key because it is not installed or there is a conflict with the parallel port. • Verify that the security key is installed directly on the parallel (printer) port and that the printer cable is connected to the back of the security key. Ensure that the printer is on and ready (or online). • Print from Windows Notepad or any text file to verify the parallel port is working properly with the security key installed.
Internal Treadmill status display	This status indicates that the software is not controlling the treadmill because “None” is selected for the treadmill type. This may be acceptable if using a treadmill that does not interface to the software and wish to use a manual controller. To have the software control the treadmill, select *Trackmaster TMX425 Model* treadmill in the Hardware of the Settings dialog. This setting controls both the TMX425 and TMX428 treadmill models.
Internal Bicycle ergometer status display	This status indicates that the software is not controlling the bicycle ergometer because “None” is selected for the bicycle ergometer type. This is currently the only option available in this version of the software. Midmark may add interfaces to selected bicycle ergometer devices in future releases of the software.

IQstress® Troubleshooting Guide	
Error Message or Problem	**Solution or Recommendation**
Lead Off: ---- Message appears in the message prompt and the lead indicators for one or more ECG leads turn red.	Electrode leads are disconnected. • Connect the electrode lead wire of the ECG module to the electrode.
Max. Test Time Exceeded. Data Storage Disabled Message appears in the message prompt.	This is not an error; the software stores ECG data and measurements for a maximum time of 100 minutes starting in the Pre-Exercise phase. Continue to monitor the patient but no measurements will be stored. Click **Exit (F12)** to end the test.
A minimum of 128M bytes of memory is required Message appears when starting a new Stress test.	The software will not start a new Stress test if the computer has less than 128MB of memory. • Either add memory to the computer or install the software on a computer that has more memory.
Operating system version must be Windows 2000 or later Message appears when starting a new Stress test.	The software requires Windows 2000 or later to run a new Stress test. • Install the software on a computer that has one of these operating systems installed.
The minimum display resolution required is 1024x768 Message appears when starting a new Stress test.	The computer being used does not meet the minimum requirements for display resolution. Change the display resolution as follows: 1. Right click on the Windows desktop. 2. Select *Properties*. 3. Click on the *Settings* tab of the *Display Properties* dialog box. 4. Adjust the display resolution using the *Screen Area* slider control to at least 1024x768. For best results use 1280x1024 or higher. 5. Click **OK**. 6. Run the software again.

B. Appendix B - Physician's Guide to the Duke Treadmill Score

The ACC/AHA Exercise Testing Guidelines[5] and the *AHA Exercise Standards For Testing and Training*[6] documents recommend using the Duke Treadmill Score (DTS).

> **NOTE:** The DTS calculations performed are intended for use by clinically competent health professionals in a clinical environment. The DTS calculation results should supplement but not replace the physician's decision process. These results should be used in conjunction with the results of the Stress test, knowledge of the patient's history and other clinical findings.

The Duke Treadmill Score[7] is a point score that can be used to classify patients into low, moderate or high-risk categories of coronary artery disease.

$$DTS = Exercisetime - (5xST\,deviation) - (4xTAI)$$

- Exercise time is in minutes using the Bruce protocol. If the Bruce protocol was not used, then the software calculates the exercise time relative to the Bruce protocol from the work level achieved.

- ST deviation is in millimeters and is calculated as the difference between the resting ST level and the minimum ST depression (or maximum elevation). If the ST deviation is less than 1.0 mm then a value of 0 is used.

  If the ST slope is positive, the software sets the ST deviation to 0. If the ST deviation is less than –1.5 mm (i.e. greater than 1.5 mm of depression) then the software uses the ST deviation even if the ST slope is positive.

- The Treadmill Angina Index (TAI) is calculated as follows:

TAI	Level Of Chest Pain Entered as Reason For Termination
0	No Angina
1	Angina Occurred During Test
2	Test Limited By Angina

The DTS point score is then used to classify the risk of CAD according to the following:

[5] Gibbons, R. J., Balady, G. J., Bricker, J. T., Chaitman, B. R., Fletcher, G. F., Froelicher, V. F., et al. (2000). ACC/AHA 2002 Guideline Update For Exercise Testing: A Report of the American College Of Cardiology/American Heart Association Task Force On Practice Guidelines (Committee on Exercise Testing). Retrieved from American College of Cardiology: www.acc.org/clinical/guidelines/exercise/dirIndex.htm

[6] Fletcher, G. F., Balady, G. J., Amsterdam, E. A., Chaitman, B. R., Eckel, R., Fleg, J., et al. (2001). Exercise Standards for Testing and Training: A Statement for Healthcare Professionals From the American Heart Association. Retrieved from Circulation: www.circ.ahajournals.org/cgi/content/full/104/14/1694

[7] Meyers, J. N., Brader, D., Madhavan, R., & Froelicher, V. F. (2001). Validation of a Specific Activity Questionnaire To Estimate Exercise Tolerance in Patients Referred For Exercise Testing. American Journal of Cardiology , 142 (6), 1041-1046.

DTS Score Range	Risk
DTS >= 5	Low
-11 < DTS < 5	Moderate
DTS <= -11	High

C. Appendix C - METS Calculations

IQstress® program calculates the estimated number of METS based upon the current work level when using a treadmill.

The ACSM's Guidelines for Exercise Testing and Prescription[1] describes two equations for METS calculation. If the treadmill speed is less than or equal to 3.7 mph, the program shall use the following equation to estimate METS.

$$METS = \frac{(0.1 \times S) + (1.8 \times S \times G) + 3.5}{3.5}$$

If the treadmill speed is greater than 3.7 mph, the software shall use the following equation to estimate METS.

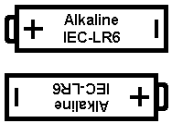
$$METS = \frac{(0.2 \times S) + (0.9 \times S \times G) + 3.5}{3.5}$$

S is speed in meters per minute. G is the treadmill grade represented as a fraction (for example a grade of 10% = 0.1).[8]

[8] ACSM's Guidelines for Exercise Testing and Prescription, 6th Edition. American College of Sports Medicine. Lippincott Williams & Wilkins, Philadelphia. 2000.[8]

D. Appendix D - Safety and International Symbols

The following symbols are used on Midmark products. These symbols appear on products when applicable. Refer to this directory for details concerning the symbols used on equipment.

Symbol	Description
	Follow instructions for use.
	Year of manufacture.
	DC VOLTAGE – (USB CONNECTION ECG DEVICES) This device uses 5 Volt power and consumes 80mA when in use.
	DC VOLTAGE – (SERIAL CONNECTION ECG DEVICES) This device uses 3 Volt power and consumes 80mA when in use.
	BATTERY ORIENTATION – (SERIAL CONNECTION ECG DEVICES) The serial port version of the ECG module uses 2 AA alkaline batteries. The icon indicates the orientation of batteries to be installed.
	IEC-601 Defibrillator-Proof Type CF equipment. Equipment displaying this symbol contains an F-type isolated (floating) applied part that provides a high degree of protection against electrical shock, and is suitable for use during defibrillation.
	ETL Listing Mark. Equipment displaying this symbol has been tested and complies with the following safety standards: Conforms to UL Std 60601-1 Certified to CAN/CSA Std C22.2 No. 601.1
	Do not dispose of this product as unsorted municipal waste. Dispose this product in accordance with national requirements per EC Directive 2002/96.

References

American College of Sports Medicine. (2000). *ACSM's Guidelines for Exercise Testing and Prescription* (6th edition ed.). Philadelphia: Lippincott Williams & Wilkins.

Ellestad, M. H. (1986). *Stress Testing* (3rd edition ed.). Philadelphia: F.A. Davis Company.

Fletcher, G. F., Balady, G. J., Amsterdam, E. A., Chaitman, B. R., Eckel, R., Fleg, J., et al. (2001). *Exercise Standards for Testing and Training: A Statement for Healthcare Professionals From the American Heart Association.* Retrieved from Circulation: www.circ.ahajournals.org/cgi/content/full/104/14/1694

Froelicher, V. F. (1994). *Manual Of Exercise Testing* (2nd edition ed.). St. Louis: Mosby.

Froelicher, V. F., & Meyers, J. N. (2000). *Exercise And The Heart* (4th edition ed.). Philadelphia: WB Saunders Company.

Gibbons, R. J., Balady, G. J., Bricker, J. T., Chaitman, B. R., Fletcher, G. F., Froelicher, V. F., et al. (2000). *ACC/AHA 2002 Guideline Update For Exercise Testing: A Report of the American College Of Cardiology/American Heart Association Task Force On Practice Guidelines (Committee on Exercise Testing).* Retrieved from American College of Cardiology: www.acc.org/clinical/guidelines/exercise/dirIndex.htm

Meyers, J. N., Brader, D., Madhavan, R., & Froelicher, V. F. (2001). Validation of a Specific Activity Questionnaire To Estimate Exercise Tolerance in Patients Referred For Exercise Testing. *American Journal of Cardiology , 142* (6), 1041-1046.

Pina, I. L., Balady, G. J., Hanson, P., Labovitz, A. J., Madonna, D. W., & Meyers, J. (1995). *Guidelines for Clinical Exercise Testing Laboratories: A Statement for Healthcare Professionals from the Committee on Exercise and Cardiac Rehabilitation.* Retrieved from Circulation: http://circ.ahajournals.org/cgi/content/full/91/3/912

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